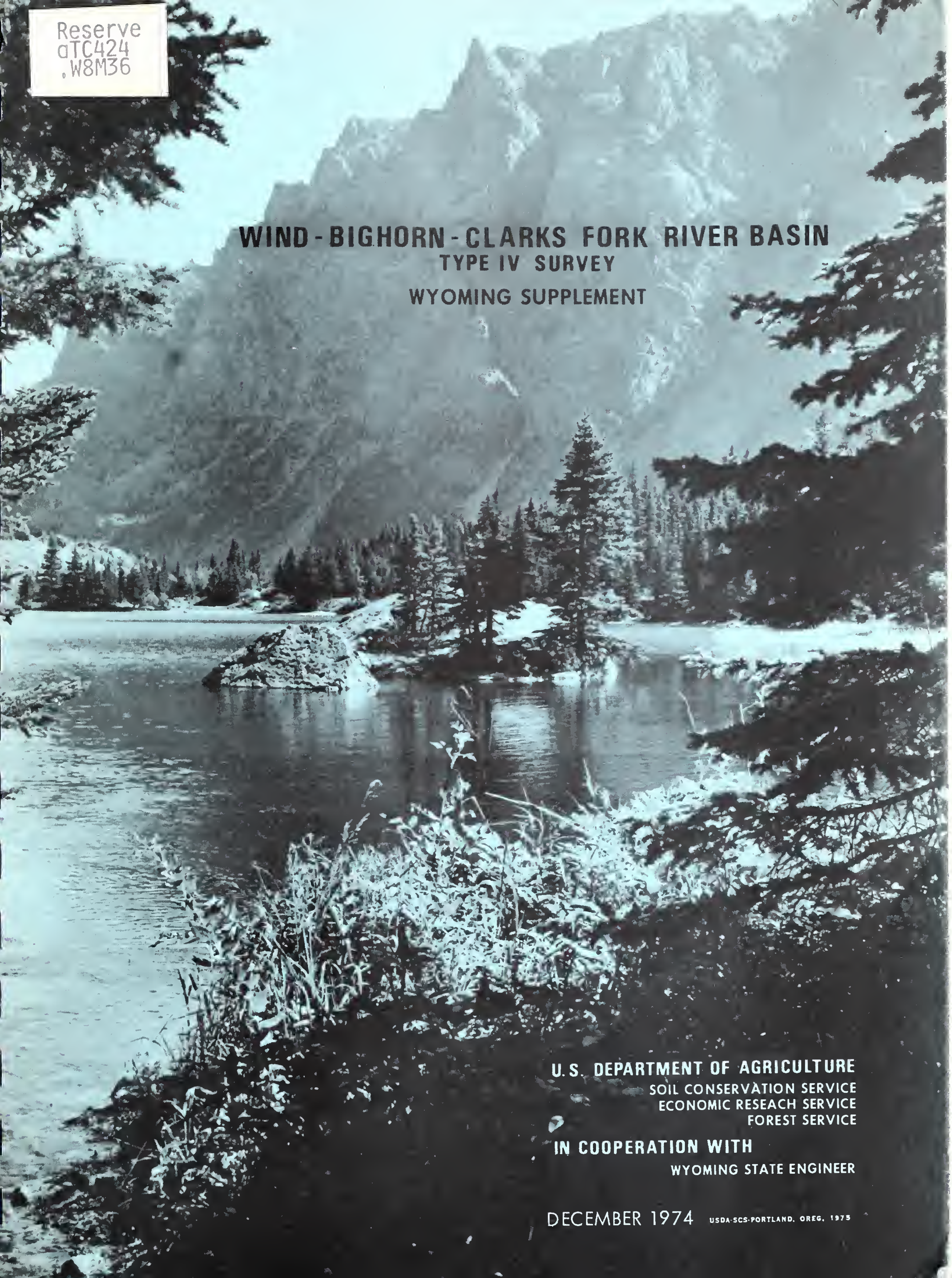
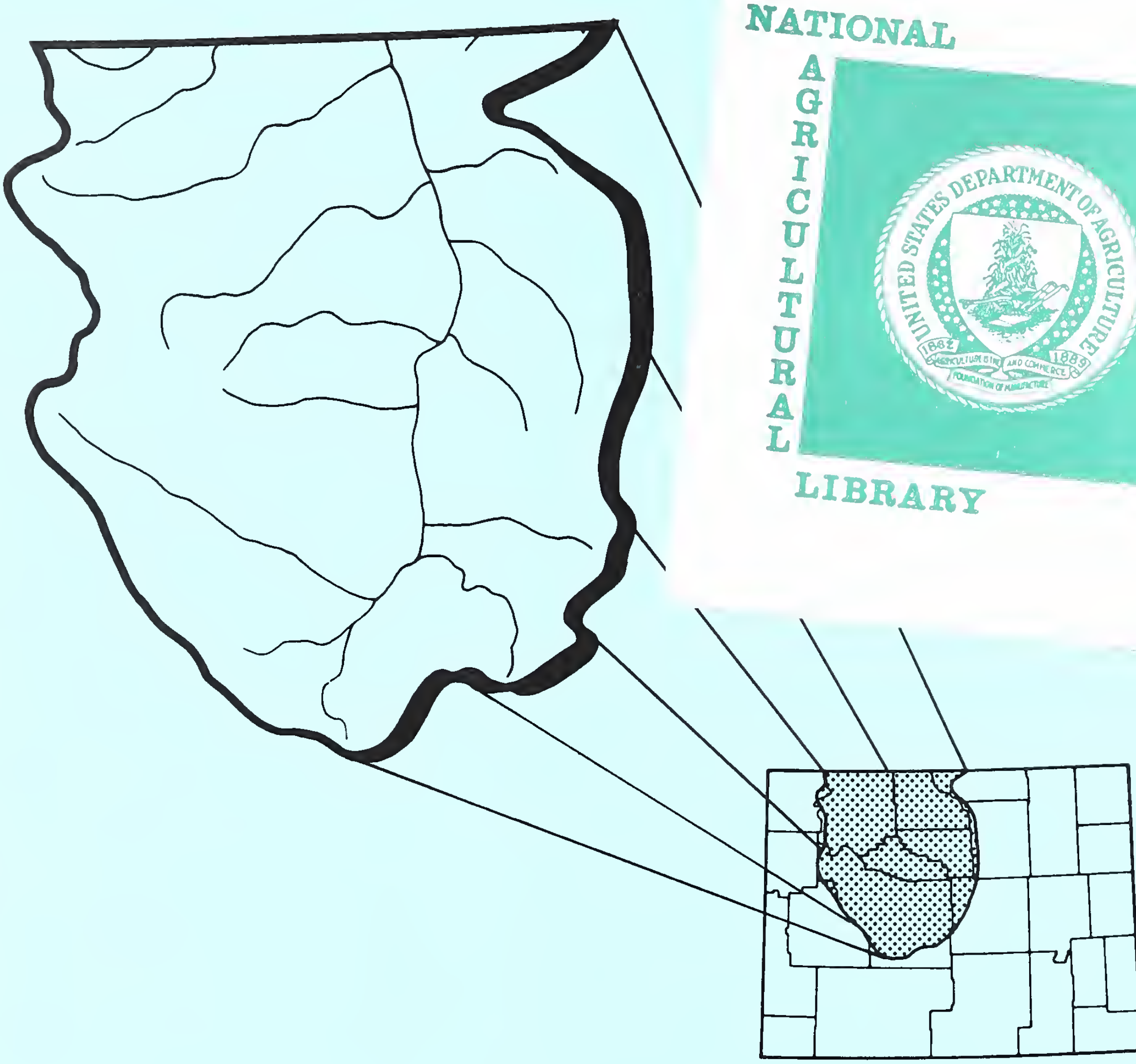


WIND - BIGHORN - CLARKS FORK RIVER BASIN
TYPE IV SURVEY
WYOMING SUPPLEMENT

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMIC RESEACH SERVICE
FOREST SERVICE

IN COOPERATION WITH
WYOMING STATE ENGINEER

DECEMBER 1974 USDA-SCS-PORTLAND, OREG. 1975



Cover Photo: Elk Lake

USDA - FOREST SERVICE PHOTO

WYOMING SUPPLEMENT

for the

WIND-BIGHORN-CLARKS FORK RIVER BASIN

Type IV Survey

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

WYOMING STATE ENGINEER

December 1974

Under Direction of

USDA FIELD ADVISORY COMMITTEE

ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN

TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5 5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

WIND-BIGHORN-CLARKS FORK RIVER BASIN
WYOMING SUPPLEMENT

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FOREWORD

It doesn't take a student of history to recognize the significance of the Wind-Bighorn-Clarks Fork River Basin. Along the banks of the Little Bighorn, Custer and his troops collected arrowheads. Lewis and Clark used many of these tributaries as highways to penetrate and explore the formidable barrier now known as the Continental Divide. Famous mountain men rendezvoused with Indians and fur companies on the banks of these famous rivers. It's a simple fact that water was the key to their survival as well as a primary source of income and a means to transport their goods. The same fact holds true for today's population. As Captain Clark and his hardy men floated their canoes down the Yellowstone River, they watched millions of acre-feet of water pound their way down toward the Gulf of Mexico. Today's observers realize that the rolling waters of the Wind-Bighorn-Clarks Fork Basin hold the key to the prosperity and well-being of many thousands of people.

Because heavy industry affects a small part of the basin, much of the landscape looks about the same today as it did when John Coulter left his moccasin prints in the dust and snow. Most of the 68,000 highly individualistic, livestock industry oriented residents might prefer to keep it that way.

This emotion is understandable but not completely realistic. From the standpoint of human needs, all of us, and particularly residents of the state, need some of the good things the basin has to offer. This plan is a proposal to enhance national, regional, and local economic development and at the same time protect environmental and human qualities. Two-thirds of the river basin is in Wyoming where the western boundary twists its way along the jagged peaks of the Continental Divide into the northwestern part of the state. Guarding the eastern perimeter of the basin looms the Big Horn Mountain Range. In between lie some of the wettest and driest lands found in any single river basin in the United States. Beaver and rendezvous are out; agriculture, oil, and tourism are in. Irrigated farmsteads nestled near the foothills and huge, far-flung ranches checkerboard the relatively flat lower lands of the basin. Scattered like orphans throughout the desert interior, thousands of "goony birds" patiently nurse millions of gallons of oil from deep in the earth. The cool temperatures and spectacular scenery of the basin and surrounding mountains attract a large number of tourists.

Starting with the Popo Agie (pronounced Po-'Po-Shia) at the extreme southern end of the Wind-Bighorn-Clarks Fork River Basin, all rivers and tributaries are children of the Yellowstone. Some begrimed by carelessness and some clean and sparkling, they dance and twist their way to the north until the family reunion is complete on the banks of the Yellowstone. Just south of Thermopolis, Wyoming, at the north end of the Wind River Canyon, is a spot called "The Wedding of the Waters." At this location the <u>Wind River</u> becomes the <u>Bighorn River</u>.

Custer might still be trying to get to the Little Bighorn if he had to negotiate his way through the maze of property divisions that exist in the basin today. His chances would be best by sticking to public lands managed by the Bureau of Land Management. More than 4,400,000 acres of public lands are strung out along the length and breadth of the basin. The going would be fairly easy, too. A good share of these lands are in flat to rolling terrain--some of it sparse desert land--where, as the old-timers say, "A horse has to gallop to graze." This public land is used mainly for the grazing of livestock.

The next biggest spread is the more than 3,000,000 acres under the brand of the U.S. Forest Service. Custer would have a rough go trying to get his troops through this country! Jagged peaks, heavy timber, deep canyons, spruce bogs, and rock fields surround the many, productive, high mountain parks. Snows all but close these national forests for 6 to 7 months each year. This closure, however, results in the most valuable resource in the basin--the snowpack. Here originates a major portion of the water for the Wind-Bighorn-Clarks Fork River Basin. This is headwaters country. From north to south, the west boundary is practically blocked out with the Shoshone National Forest. The east boundary is composed of the Big Horn National Forest and Bureau of Land Management lands.

There is a good reason why conservationists smile when the Wind-Bighorn-Clarks Fork Basin is mentioned! Conspicuous because of the large area they cover, and with names that sing of history and matchless beauty, seven areas classified either as wilderness or primitive areas frame the picture of the Wind-Bighorn-Clarks Fork River Basin. A name like Cloud Peak Primitive Area is enough to strike weak even the most callous industrialist. How about Beartooth Primitive Area; or Popo Agie Primitive Area; or Glacier Primitive Area; or, if you're geologically inclined, the Stratified Primitive Area? These areas are all under study for reclassification to wilderness status. The North and South Absaroka Wilderness Areas already have this designation.

By diminishing size, the next block of land ownership occurs in the private sector. These lands run a close second to the national forest with more than 2,700,000 acres. They consist primarily of farm and ranch operations with urban development an almost insignificant part of the land use pattern. There are almost 2,000,000 acres in the Wind River Indian Reservation. State-owned lands total about 604,000 acres. This figure includes nearly 20,000 acres under the jurisdiction of the State Game and Fish Department. The Bureau of Reclamation administers about 400,000 acres. Other federal agencies barely get in the picture with under 55,000 acres.

If you're a horned toad, there is some good news and some bad news. You'll love the desert-like interior of the basin where precipitation can be as little as 3 inches per year. However, near the 14,000 foot level at the Continental Divide you just wouldn't be happy with the drastic ecological change that results from as much as 70 inches of precipitation annually.

On the other hand, if you can make the adjustment, you may enjoy the solitude. There are more than 1,300,000 acres of designated wilderness and primitive areas to scamper around in. Surrounding these areas are about 1,600,000 acres of multiple use managed national forest lands with about 31,000 acres of state and private properties sprinkled around here and there inside the national forest boundaries to provide contrast.

You've heard the Indians speak of the "Happy Hunting Grounds"? Well, this must be the place! Inside the boundaries of the Wind-Bighorn-Clarks Fork River Basin is an astounding collection of big game species. Elk, deer, bear, moose, antelope, bighorn sheep, and mountain goats are found in the basin. Most of their habitat occurs on federal lands. Summer range is plentiful and presents no problem. Winter range is the big cause for concern. National forests provide about 276,000 acres for the winter grazing of big game animals. That sounds like a bunch until you consider that the basin supports many thousands of deer and elk. "Critical game winter range" is a designation rightfully tacked on large areas of land in the basin. If you think federal lands support all the wintering big game, talk to any of the many irate ranchers in the basin. They spend a generous amount of time each winter boarding up haystacks and repairing fences torn up by empty-bellied game animals that refuse to recognize man-made barriers and property boundaries.

"KEEP WYOMING GREEN" is a slogan that applies to more than just fire prevention. Ask any businessman about the green stuff scattered around by recreationists who visit the basin. Sightseeing, camping, hunting, fishing, guest ranches, and resorts are attractions of major significance which have a profound impact on the basin's economy.

We've been talking in generalities, and this is fine when we want to provide a panoramic "snapshot" of the basin as a whole. Interesting and sometimes startling information is revealed, however, when specific segments of the photo are blown up for a detailed look.

USDA SUPPLEMENTAL REPORT OF A STUDY OF WATER AND RELATED LAND RESOURCES OF THE WIND-BIGHORN-CLARKS FORK RIVER BASIN IN WYOMING

I. INTRODUCTION

This report presents the results of a study of problems and needs, potentials, and opportunities for the use and development of water and related land resources in the Wind-Bighorn-Clarks Fork River Basin in Wyoming. Opportunities for programs and projects which can be administered by agencies of the U. S. Department of Agriculture are identified.

This study is needed to provide information for a coordinated plan for systematic multipurpose development of the natural resources of this basin.

The objective of this study and report is to contribute to the coordinated and orderly development, management, and use of water and related land resources of the basin.

This report includes an inventory of natural resources, an analysis of economic development, an inventory of water and related land resource problems, and an identification of present and future needs for development of these resources. There is a discussion of existing projects and programs and an estimate of the development potential of these resources. A description of identified opportunities for U. S. Department of Agriculture programs and their impacts is part of the report. This report covers an area of about 20,590 square miles in north-central Wyoming. The mainstem of the Bighorn River flows northward and is fed by tributaries draining from high mountains on the western, southern, and eastern sides of the basin. The basin includes parts of the Beartooth, Absaroka, Wind River, and Big Horn Mountain Ranges. In the southern portion of the study area, the Wind River basin is separated from the Bighorn River basin by the Owl Creek Mountains, an intermediate range lying in a west to east direction. A portion of the Little Bighorn River basin is included in the study area. The population in the Wyoming portion of the basin was 68,407 in 1970. Dubois, Lander, Riverton, Thermopolis, Worland, Cody, Powell, and Lovell are the major towns.

This study has been made under the authority of Section VI of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). By this act the Secretary of Agriculture is authorized to cooperate with other federal, state, and local agencies in making investigations of watersheds, rivers, and other waterways. The Soil Conservation Service, Forest Service, and Economic Research Service of the U. S. Department of Agriculture have participated in this study in accordance with memorandums of understanding dated February 2, 1956, as revised April 15, 1968.

The State of Wyoming requested this study. A number of state agencies have cooperated by supplying data and field and office reviews of the study. The U. S. Bureau of Indian Affairs, the U. S. Bureau of Reclamation,

the U. S. Bureau of Land Management, and other federal agencies have provided data and otherwise contributed to the study. Close coordination was maintained throughout the study between the participating agencies and the sponsoring state agencies.

Employees of the Soil Conservation Service, Forest Service, and Economic Research Service have examined and analyzed existing source material and performed new field reconnaissance investigations. Economic studies included gathering data about the general economy, with special emphasis on the agricultural sector, identifying the relationships between and among factors that influenced the evolution of the economy, and projecting the volume and value of agricultural output. Estimates of gross farm income, employment, and use of rural lands were derived from analysis of historical and projected agricultural production.

An apprisal of potential small watershed projects and opportunities for other departmental programs has been made to estimate the extent to which these programs may help meet the needs for present and future development of water and related land resources in the basin. The intensity of investigation for potential watershed projects was similar to that usually followed in making preliminary investigations for such projects. Watershed investigation reports have been written for those watersheds where projects were found to be feasible.

The forest resources, their present use, volume, values of output, and impact on employment were evaluated. An estimate of future need for timber, range, recreation, fish, and wildlife has been made for the basin.

This report is a new source of data for water, land, and interrelated resources for the Wind-Bighorn-Clarks Fork River Basin area. It should be a very useful source of information for citizens in the basin and for local, state, and federal planning agencies interested in developing coordinated resource development in the basin and in guiding the investment of funds in the public interest.

Data, assistance, and cooperation in analysis of data and review of the report and project recommendations have been received from many local, state, and federal agencies. The following federal and state agencies contributed to the study:

Contributing agencies
Soil Conservation Service
Forest Service
Economic Research Service
Agricultural Stabilization and Conservation Service
Farmers Home Administration
Rural Electrification Administration
National Weather Service

Geological Survey
Statistical Reporting Service
Bureau of Land Management
Bureau of Reclamation
Corps of Engineers
Bureau of Sport Fisheries and Wildlife
Bureau of Outdoor Recreation
Bureau of Indian Affairs
Wyoming State Conservation Commission
Conservation Districts
Wyoming Department of Agriculture
Wyoming Game and Fish Department
Department of Economic Planning and Development
University of Wyoming
Wyoming State Engineer - Wyoming Water Planning Program
Wyoming State Forestry Division
Wyoming Water Quality Division
Wyoming Recreation Commission

II. NATURAL RESOURCES OF THE BASIN

The basic natural resources of the Wind-Bighorn-Clarks Fork River Basin are the building blocks with which to implement a plan for the development of the water of the basin. Consideration must be given to the location of the basin, the climate, physiography, geology, properties of the soils, land, water, vegetation, fish, wildlife, recreational resources, and other factors of the natural environment for proper planning of resource development. The quantity and quality of each of these natural resources affects the efficiency of the use and development of other resources. This chapter describes and contains inventories of many of these resources.

LOCATION AND SIZE

The Wyoming portion of the Wind-Bighorn-Clarks Fork River Basin is located in north central Wyoming as shown in figure II-1. Its boundary encompasses an area of about 13,179,000 acres, or about 20,590 square miles. This includes nearly all of Big Horn, Hot Springs, Park, and Washakie Counties; most of Fremont County; small portions of Johnson, Natrona, Sheridan, Teton, and Sublette Counties; and a small portion of Yellowstone National Park.

The basin is bordered by the Yellowstone, Snake, and Green River Basins on the west and the Platte, Powder, and Tongue River Basins on the south and east. Roughly heart-shaped, the basin averages 140 miles across from east to west and 160 miles from the southern boundary to the Wyoming-Montana state line. The basin may be divided into four hydrologic subbasins--the Wind, Bighorn, Clarks Fork, and Little Bighorn. Table II-1 lists respective sizes of each subbasin.

Table II-1--Areas of subbasins

Subbasin	Acres	Percent
Wind	4,992,740	38
Bighorn	7,196,060	55
Clarks Fork	796,570	6
Little Bighorn	193,670	1
Total	13,179,040	100

The Bighorn River and the Clarks Fork River are major tributaries of the Yellowstone River, itself a major tributary of the Missouri River. The Wyoming portion of the Wind-Bighorn-Clarks Fork Basin represents 4 percent of the area of the Missouri River Basin and 21 percent of the area of Wyoming.

CLIMATE

The climate of the basin varies from the cool, arid, desertic conditions prevailing at the lower elevations to the cold, humid, alpine zones in the higher mountain areas. This variation is influenced by the mountain ranges which lie in a general north-south direction, perpendicular to the prevailing westerlies. Winters are long and cold with occasional warm spells, and summers are short, dry, and warm. The spring season is cool with frequent periods of precipitation, and the fall season is cool and pleasant with occasional rain and snow storms.

Precipitation and, to a lesser extent, temperature vary with elevation. The average annual temperature at the town of Basin (elevation 3,860) is 45.7° F. and at Dubois (elevation 6,917) it is 40.5° F. Stations at lower elevations will frequently experience lower temperatures during cold periods because of the drainage of cold air from the mountains. Recorded extremes of temperature for the basin are -51° F. at Worland, Basin, and Lovell, and 114° F. at Basin. The growing season normally ranges from about 60 days near Dubois to 160 days near the town of Basin. In the high valleys and mountains, frost may occur any time during the year.

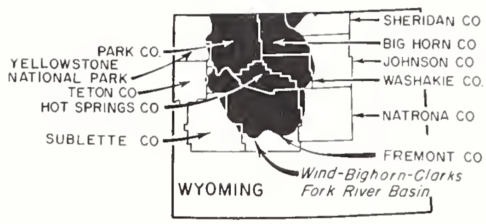
Average annual precipitation varies from less than 6 inches near the town of Basin along the Bighorn River to over 70 inches in the higher mountain ranges. At lower elevations about half of the annual precipitation occurs in scattered spring and summer thunderstorms. At higher elevations thunderstorms occur often in the summer, and snowfalls are frequent in the other seasons. Snowfall over the basin varies from an average of 15 to 20 inches at the lower elevations to over 200 inches in the mountains. A deep snowpack develops through the winter in the mountains and stores winter precipitation for release in high streamflows in the spring. Figure II-2 is a map of annual precipitation made as part of this study effort.

Evaporation losses are fairly high because of the low relative humidity and the high percentage of sunshine. Growing season evaporation varies from 40 to 60 inches at the lower elevations.

PHYSIOGRAPHY AND GEOLOGY

The basin is located within the Middle Rocky Mountains and Great Plains Divisions of the Northern Rockies and Great Plains Physiographic Provinces. It is bounded by the Bighorn Mountains, the Casper Arch, Beaver Rim, Wind River Mountains, the Absaroka Range, and the Pryor uplift. As mentioned before, there are four major subbasins. The rivers that drain these subbasins are primarily consequent streams that have cut deep canyons through the highlands which separate the subbasins.

The altitude of the basin floor ranges from 4,000 to 6,500 feet with elevations in the bordering mountains exceeding 12,000 feet. The highest



LOCATION MAP

FIGURE II-1

PROJECT MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

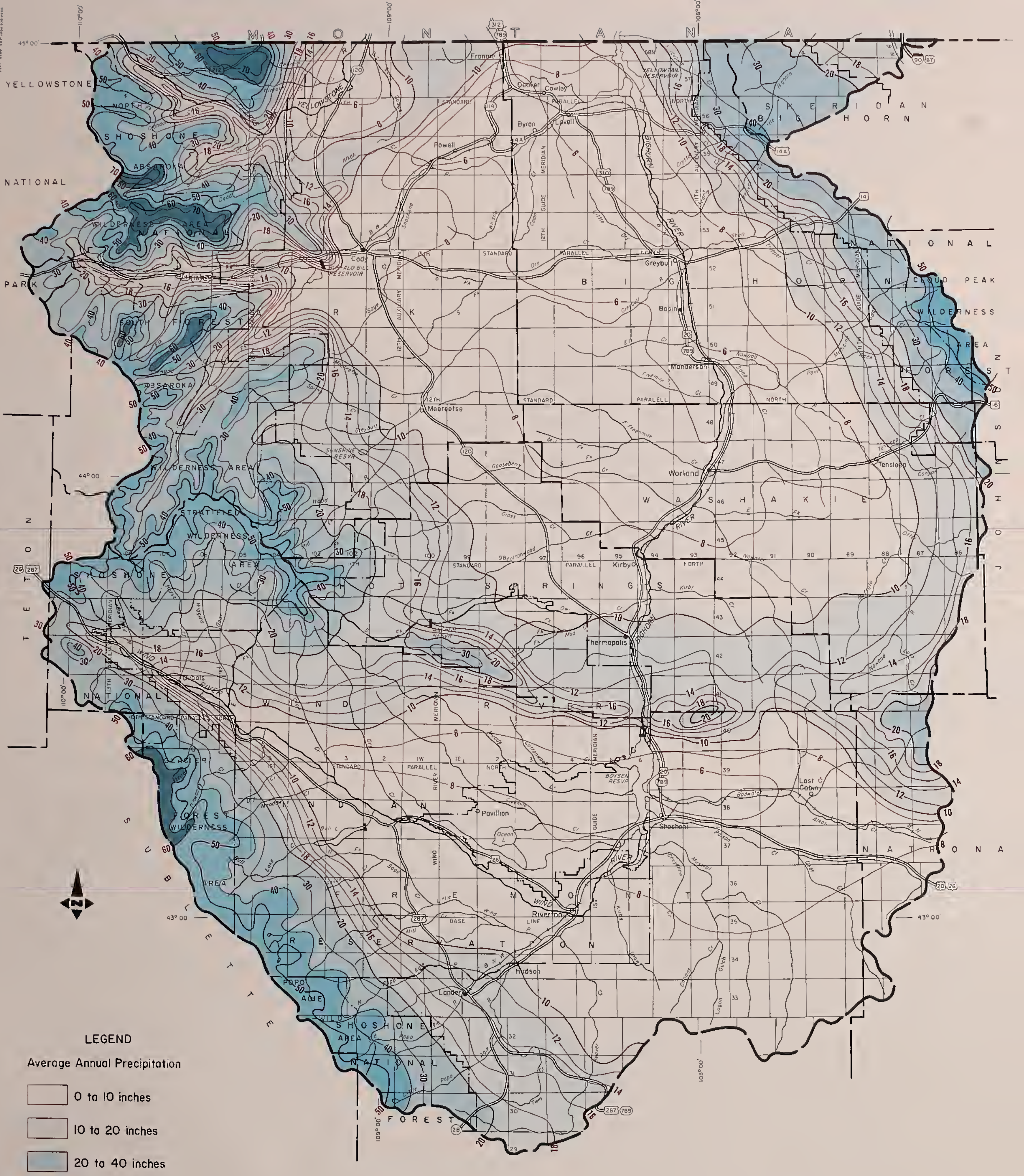
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,000,000

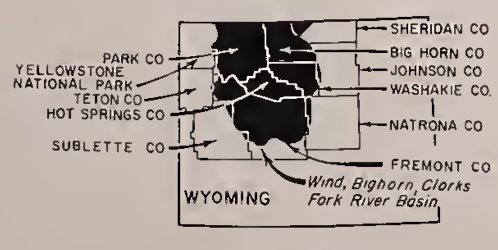
ALBERS EQUAL AREA PROJECTION



LEGEND

Average Annual Precipitation

- 0 to 10 inches
- 10 to 20 inches
- 20 to 40 inches
- 40 to 60 inches
- Over 60 inches



LOCATION MAP

FIGURE II-2

AVERAGE ANNUAL PRECIPITATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

Winter lays a heavy blanket of snow on the mountains.

Soil moisture from snowmelt nourishes plants and animals in the spring.

PLATE 1

The deeply incised Bighorn Canyon now holds the water of Bighorn Lake. This magnificent scenic area, once very difficult to enter, can now be easily seen from a boat.

BUREAU OF RECLAMATION PHOTO

The Wind River Canyon--geologist's textbook, camper's delight, scenic wonder, and fisherman's paradise.

BUREAU OF RECLAMATION PHOTO

This basin produces an important part of the nation's oil supply.

PLATE 2

mountain is Gannet Peak at 13,785 feet, and the lowest point in elevation is slightly less than 3,500 feet where the Bighorn River leaves Wyoming.

The topography of the basin is very diverse ranging from high, alpine areas with permanent snow fields and glaciers to the desertic basin floor. These major features are interspersed with timbered footslopes, deep canyons, dissected lesser plateaus, sharp ridges, rugged badlands, and terraced river valleys. The wide range in erosion resistance of the underlying rock layers is the principal factor in development of these features. Figure II-3 is a generalized geology map of the basin. The more resistant rocks stand as erosional remnants or in high relief while the softer rocks have been eroded into open valleys. The precipitous canyons along the footslopes have been cut into durable rock over a prolonged period by swift flowing streams.

The geologic formations in the basin range in age from Precambrian to Quaternary with all intervening ages expect for the Silurian being represented. Crystalline rocks of Precambrian Age are exposed along the high mountain divides on the outer margin of the basin with the exception of the Absaroka Range, which is composed of volcanic extrusive and intrusive rocks of Tertiary Age. Paleozoic and Mesozoic sedimentary rocks occur around the flanks of the basin. The floor of the basin contains sedimentary rocks of Tertiary Age, while unconsolidated alluvium of Quaternary Age occurs along the river valleys.

Several periods of movement of the earth's crust took place in the basin during Precambrian time. This faulting and folding played a major role in determining the form of the rim of the present basin. The area was generally quiescent during Paleozoic and Mesozoic time with only local vertical adjustment with associated folding occurring during this long period of time. This relatively inactive tectonic period ended with the start of the Laramide orogeny which reached its peak in late Paleocene to early Eocene time. This mountain building period was closely followed by volcanic activity along the northwest margin of the basin where thousands of cubic miles of pyroclastic rocks were extruded. The basin was then filled with sediments to nearly a plain with only the core of the mountains protruding above the plain. The area was then upwarped and faulted and rejuvenated erosion resulted in canyon cutting and reexcavation of the basin. Local volcanic activity also occurred at this time. Subsequent periods of alpine glaciation and erosion have modified the basin into its present form.

MINERAL RESOURCES

Petroleum, natural gas, uranium, iron, bentonite, gypsum, and sulfur are presently the most important minerals being produced in the basin. Current annual oil production is between 65 to 70 million barrels, while gas production is about 75 billion cubic feet annually from oil and gas fields scattered throughout the basin. Associated sulphur production from sour gas is about 30,000 long tons per year.

About 2 million tons of uranium ore are processed annually, primarily by three mills located in the Gas Hills area southeast of Riverton. An iron mill on the basin boundary southwest of Lander processes some 4 million tons of raw iron ore per year. About 875,000 tons of bentonite are produced annually in the Greybull area. Gypsum production amounts to 350,000 tons per year primarily in the Cody-Lovell area. Clay deposits are processed for tile in the Lovell area, and feldspar is being mined on Copper Mountain near Boysen Reservoir.

Significant reserves of good grade bituminous coal occur in the basin. Large amounts have been produced in the past, but production is presently limited to small amounts for local use. Sand and gravel deposits occur along the mainstem drainages and are produced locally. Phosphate, limestone, and building stone quarries occur but are currently of no significant commercial importance. Copper, lead, gold, and other metals associated with the Precambrian rocks occur in significant quantities to have been mined in the past, but because of economic conditions, are no longer produced.

LAND RESOURCES

Land is one of the basic resources used by man and is the most common resource in private ownership. The value of land for agricultural use varies with its productive capacity. This potential capacity is dictated by soils type, climate, vegetative cover, and the availability of water. Land ownership, soils, vegetative cover, and land uses in the basin are described in this section.

Land ownership and administration

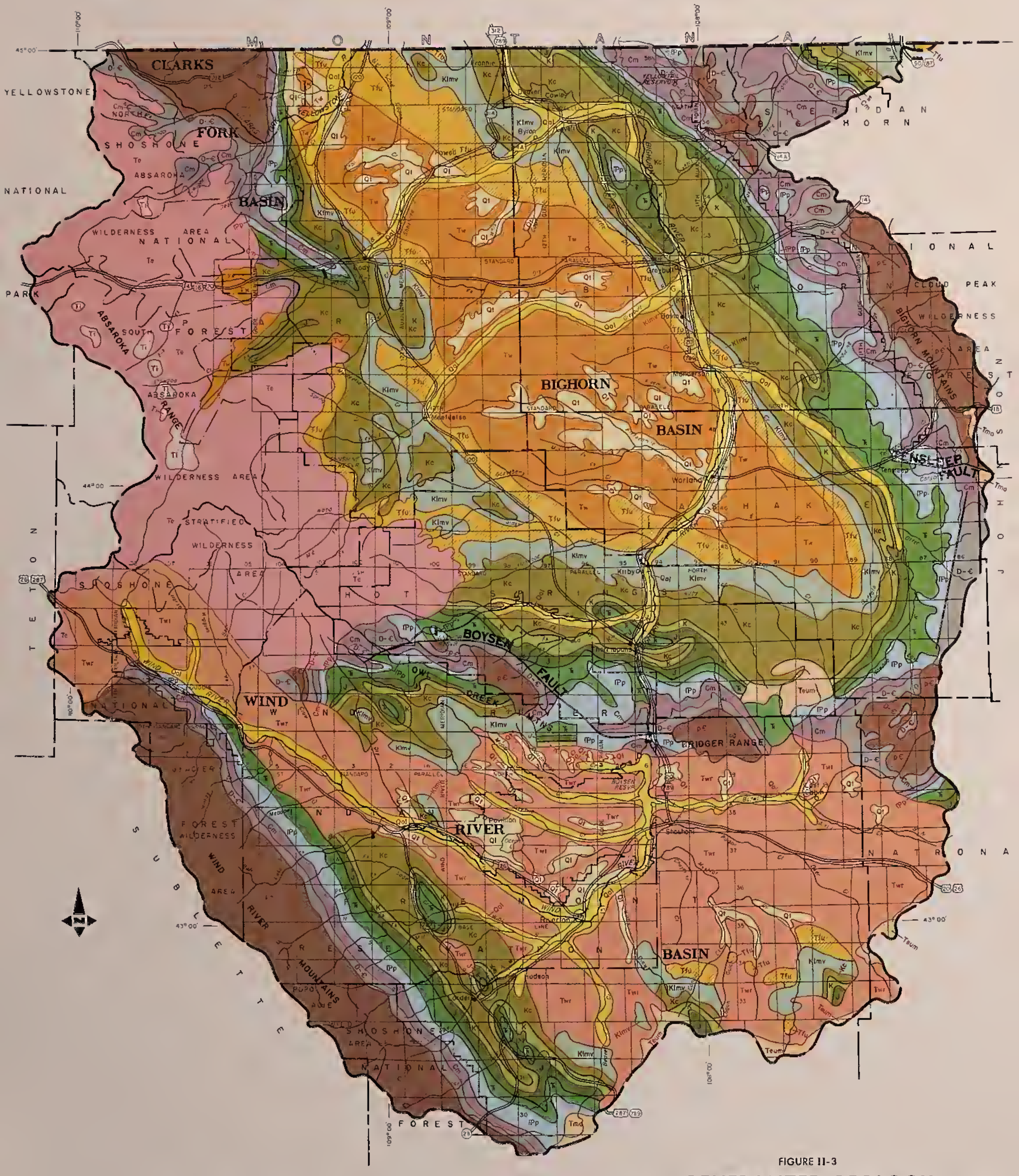
Data on land ownership and administration is given in tables II-2 and II-3 by watersheds, subbasins, and counties. A map of land ownership is on figure II-4. About 60 percent of the basin is public lands with 23 percent administered by the U. S. Forest Service, 33.6 percent by the Bureau of Land Management, 3.1 percent by the Bureau of Reclamation, 0.4 percent by other federal agencies, and 4.6 percent by the state. The remaining lands are in private ownership held either by individuals, corporations, or the Arapahoe and Shoshone Indian tribes on the Wind River Indian Reservation.

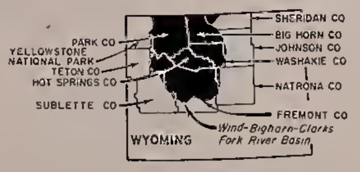
Lands administered by the U. S. Forest Service are in the Shoshone National Forest (2,468,880 acres) and the Big Horn National Forest (556,710 acres). Lands administered by the Bureau of Land Management are primarily desert and range lands in the lower elevations of the basin.

Lands set aside by the Bureau of Reclamation are intended to be irrigated by reclamation projects. These lands are normally administered in cooperation with the Bureau of Land Management. State lands are those used by the Wyoming Game and Fish Commission (19,960 acres) and by other state agencies and include "school" lands (584,340 acres).

LEGEND

- Qal — Quaternary Alluvium
- Qt — Quaternary Terrace
- Ti — Tertiary Intrusive Volcanics
- Te — Tertiary Extrusive Volcanics
- Tmo — Miocene & Oligocene Undivided
- Teum — Upper & Middle Eocene Rocks Undivided
- Twr — Tertiary Wind River Formation
- Tw — Tertiary Wasatch Formation
- Tfu — Tertiary Fort Union Formation
- Klmv — Cretaceous Lance, Meeteetse, & Meseverde Formations
- Kc — Cretaceous Calorado Group
- K — Cretaceous Cloverly, Morrison Formations
- J — Jurassic Rocks Undivided
- Ŧ — Triassic Rocks Undivided
- IPp — Pennsylvanian & Permian Rocks Undivided
- Cm — Mississippian Undivided
- D-Є — Devonian to Cambrian Rocks Undivided
- pЄ — Pre-Cambrain Granite
- Fault
- Inverted Fault





LOCATION MAP

FIGURE II-3

GENERALIZED GEOLOGY

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

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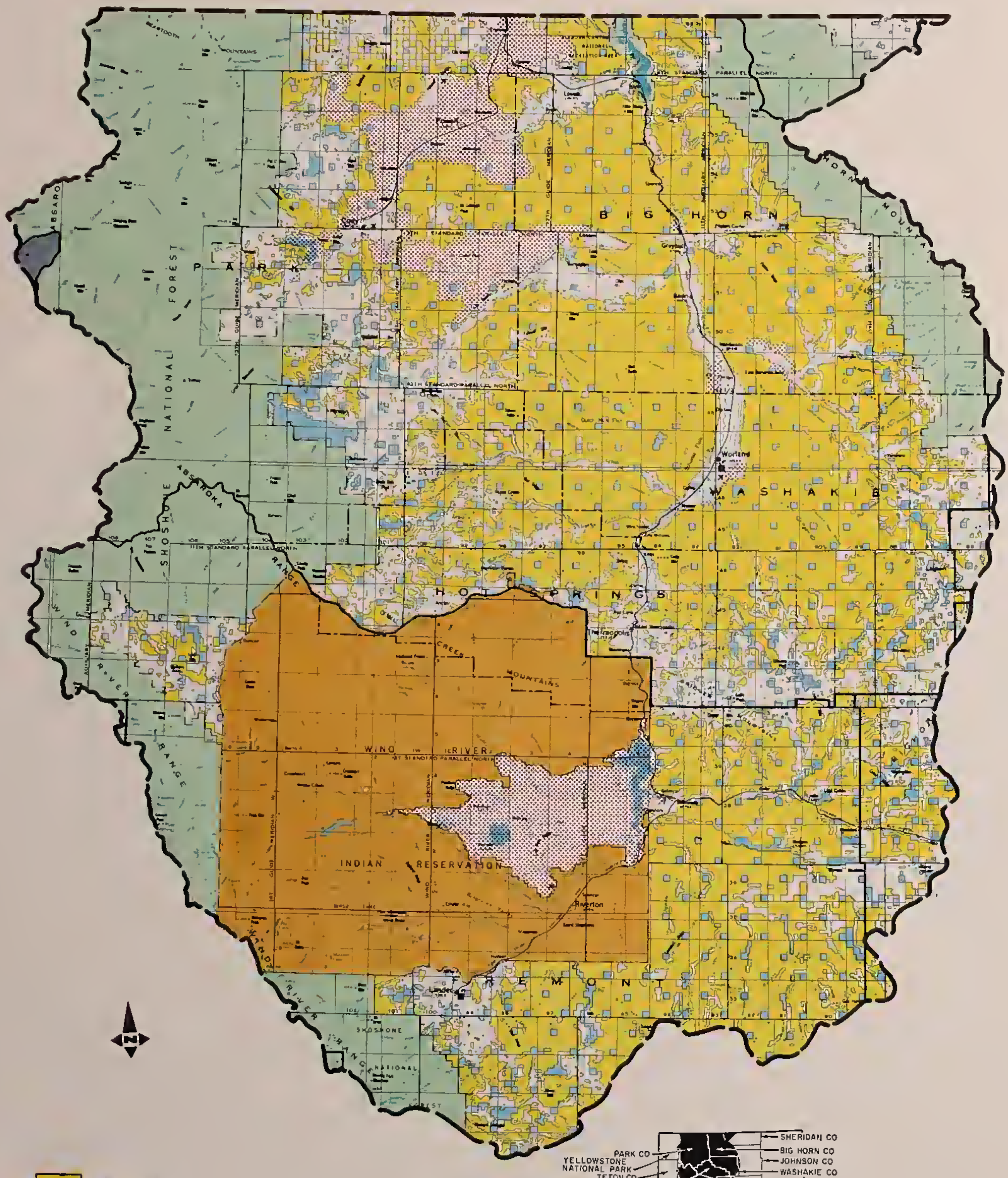


Public Lands

National Parks and Monuments

B. L. M. Aquired Land

Indian Reservation

State Lands

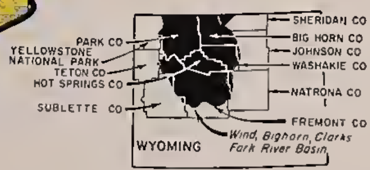
Private Lands

National Forests

Bureau of Reclamation Jurisdiction

Prior Mountion Wild Horse and Wildlife Range

National Recreation Areas



LOCATION MAP

FIGURE II-4

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

From map by Bureau of Land Management

Table II-2--Surface ownership and administration by counties in the Wind-Bighorn-Clarks Fork River Basin, January 1972

Political Subdivision	Unit	Area in the Basin	Private: Private Ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies	Percent of political sub-division
Big Horn Co.	acres	2,001,320	361,280	0	920	74,680	1,130,880	357,160	50,440	25,960	
	percent	15.2	18.1	0	0.1	3.7	56.5	17.8	2.5	1.3	100.0
Fremont Co.	acres	4,628,090	578,550	1,687,310	11,360	154,880	1,162,610	860,520	162,540	10,520	
	percent	35.1	12.5	36.5	0.2	3.4	25.1	18.6	3.5	0.2	78.0
Hot Springs Co.	acres	1,337,110	391,000	265,790	0	76,500	540,980	59,760	3,080	0	
	percent	10.1	29.2	19.9	0	5.7	40.5	4.5	0.2	0	100.0
Johnson Co.	acres	36,420	16,030	0	0	560	1,280	18,550	0	0	
	percent	0.3	44.0	0	0	1.5	3.5	51.0	0	0	1.4
Natrona Co.	acres	340,480	161,200	0	0	37,560	141,720	0	0	0	
	percent	2.6	47.4	0	0	11.0	41.6	0	0	0	9.9
Park Co.	acres	3,186,260 [3/]	815,530	0	1,640	142,180	493,370	1,540,290	193,250	0	
	percent	24.2	25.6	0	0.1	4.4	15.5	48.3	6.1	0	95.1
Sheridan Co.	acres	193,660	41,050	0	4,800	4,140	260	143,230	0	160	
	percent	1.5	21.2	0	2.5	2.1	0.1	74.0	0	0.1	12.0
Sublette Co.	acres	8,290	0	0	0	0	0	8,290	0	0	
	percent	0.1	0	0	0	0	0	100.0	0	0	.3
Teton Co.	acres	2,560	0	0	0	0	0	2,560	0	0	
	percent	-- [1/]	0	0	0	0	0	100.0	0	0	0.1
Washakie Co.	acres	1,426,600	338,020	0	1,240	93,840	955,030	35,230	3,240	0	
	percent	10.8	[illegible]	0	0.1	[illegible]	66.9	2.5	0.2	0	99.0
Yellowstone Park	acres	18,250	0	0	0	0	0	0	0	18,250	
	percent	0.1	0	0	0	0	0	0	0	100.0	0.9
Total	acres	13,179,040	2,702,660	1,953,100 [2/]	19,960	584,340	[illegible]	3,025,590	412,350	54,890	
	percent	100.0	20.5	14.8	0.2	4.4	33.6	23.0	3.1	0.4	

1/ -- = less than 0.1 percent.
2/ This area may include some land in private, non-Indian ownership. The BIA published data for this area is 1,886,374 acres.
3/ No part of Yellowstone National Park is included in this figure.

Table II-3--Surface ownership and administration in the Wind-Bighorn-Clarks Fork River Basin by watersheds and subbasins, January 1972

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
	Wind River Subbasin	acres								
14e-1	Upper Poison Creek	230,570	118,410	0	0	25,760	86,400	0	0	0
14e-3	Lower Poison Creek	103,080	11,040	2,280	0	5,160	79,920	0	4,680	0
14e-4	Fivemile Creek	122,150	2,780	115,370	0	0	0	0	4,000	0
14e-5	Muddy Creek	244,180	0	192,960	0	0	880	0	50,340	0
14e-6	Dry Muddy Creek	142,220	0	112,260	0	0	0	0	29,080	880
14el-1	Upper Wind River	143,930	21,360	0	0	1,920	3,880	116,770	0	0
14el-1a	Horse Creek	104,900	31,400	0	0	7,520	18,930	47,050	0	0
14el-2	Wiggins Fork	143,430	8,030	0	3,760	6,080	6,680	118,880	0	0
14el-3	Jakey's Fork-Torrey Creek	187,800	25,320	6,200	3,240	1,800	6,080	145,160	0	0
14el-4	East Fork	139,590	10,480	13,750	680	2,800	3,120	108,760	0	0
14el-5	Crow Creek	118,010	0	118,010	0	0	0	0	0	0
14el-6	Dinwoody Creek	245,400	0	166,000	0	0	0	79,400	0	0
14el-7	Bull Lake	163,190	0	120,710	0	0	0	42,200	280	0
14el-8	Crowheart Butte-Dry Creek	168,940	7,240	161,700	0	0	0	0	0	0
14el-9	Midvale	180,540	104,640	10,620	2,160	0	0	0	53,480	9,640
14el-10	Riverton	125,470	600	113,420	0	0	0	0	11,450	0
14el-12	Kirby Draw	125,770	3,440	95,920	0	960	24,090	0	1,360	0
14ela-1	Little Popo Agie	238,630	48,840	0	1,360	18,240	117,630	52,560	0	0
14ela-2	Middle Popo Agie	166,120	58,840	0	160	9,280	14,080	83,760	0	0
14ela-2a	North Popo Agie	117,600	12,280	36,540	0	3,400	8,960	56,420	0	0
14ela-3	South Lower Little Wind	109,940	0	109,900	0	0	0	40	0	0
14ela-4	Upper Little Wind	161,990	0	146,110	0	0	0	15,880	0	0
14ela-4a	North Lower Little Wind	159,760	0	159,760	0	0	0	0	0	0
14ela-5	Upper Beaver Creek	180,750	40,360	0	0	14,000	122,090	4,300	0	0
14ela-6	Lower Beaver Creek	94,210	2,200	19,580	0	6,640	65,790	0	0	0
14e2-1	Muskrat	246,910	29,240	1,080	0	17,720	197,510	0	1,360	0
14e2-2	Conant Creek	178,320	14,320	0	0	12,400	151,360	0	240	0
14e2-3	Lower Muskrat	59,910	1,840	720	0	3,080	54,270	0	0	0
14e3-1	Alkali Creek	149,480	35,160	0	0	16,000	98,320	0	0	0
14e3-2	Upper Badwater Creek	133,840	55,720	0	0	14,560	63,560	0	0	0
14e3-3	Bridger Creek	117,800	58,880	0	0	6,380	52,540	0	0	0
14e3-4	Lower Badwater Creek	188,310	33,400	180	0	16,000	131,780	0	6,950	0
	Subtotal of 32 watersheds	4,992,740	735,820	1,703,070	11,360	189,700	1,307,870	871,180	163,220	10,520
	Percent of subbasin	100.0	14.7	34.1	0.2	3.8	26.2	17.4	3.3	0.2
	Percent of basin total ownership	31.9	27.0	87.2	56.9	32.5	29.5	29.0	39.6	19.2

Table II-3--Surface ownership and administration (Continued)

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
	Bighorn River Subbasin	acres								
14e-6a	Red Canyon Creek	100,960	7,280	87,560	0	0	6,120	0	0	0
14e-7	Buffalo Creek	93,900	64,660	7,200	0	9,840	12,200	0	0	0
14e-8	Upper South Fork Owl Creek	81,100	27,120	26,040	0	2,560	16,740	7,480	1,160	0
14e-8a	Upper Owl Creek	163,700	45,160	64,620	0	6,440	38,080	9,280	120	0
14e-9	Mud Creek	78,170	7,720	64,610	0	0	5,840	0	0	0
14e-10	Candy Jack	1,410	570	0	0	320	520	0	0	0
14e-10a	East Thermopolis	21,690	10,690	0	0	6,280	4,720	0	0	0
14e-10b	Lucerne	24,710	13,710	0	0	1,640	9,280	0	80	0
14e-10c	Upper Hanover	37,620	9,080	0	0	1,080	27,100	0	360	0
14e-11	Kirby Creek	169,140	49,720	0	0	15,480	103,940	0	0	0
14e-12	No Water Creek	164,100	23,800	0	0	7,640	132,660	0	0	0
14e-12a	East Fork No Water Creek	100,760	0	0	0	6,720	93,960	0	80	0
14e-13	Gebo Mine	85,630	11,120	0	0	4,160	70,310	0	40	0
14e-14	Upper Cottonwood	125,670	38,440	0	0	6,880	74,150	6,160	40	0
14e-15	Gooseberry Creek	232,290	68,840	0	0	18,000	136,150	8,580	720	0
14e-16	Lower Cottonwood	176,100	52,080	0	0	15,320	107,940	720	40	0
14e-17	Colter	16,340	4,120	0	0	920	11,300	0	0	0
14e-17a	WA Sage	9,880	7,600	0	0	0	2,200	0	80	0
14e-17b	Lower Hanover	49,730	28,050	0	0	2,640	17,600	0	1,440	0
14e-19	Upper Fifteenmile	105,600	32,680	0	0	5,040	67,880	0	0	0
14e-20	Lower Fifteenmile	235,010	11,040	0	0	10,900	213,070	0	0	0
14e-21	Fivemile-Elk Creek	187,400	30,790	0	0	5,160	148,410	0	3,040	0
14e-22	Upper Shell Creek	168,440	23,560	0	0	1,280	47,100	96,500	0	0
14e-23	Lower Shell Creek	204,540	27,160	0	0	8,800	130,660	37,920	0	0
14e-24	Bear Creek	73,630	4,800	0	0	3,600	61,950	3,000	280	0
14e-24a	Crystal Creek	115,180	21,520	0	0	4,520	62,930	21,290	400	4,520
14e-25	Dry Creek	246,910	32,840	0	0	11,080	81,480	0	121,510	0
14e-26	Little Dry Creek	105,500	5,720	0	0	5,200	92,500	0	2,000	0
14e-27	Crooked Creek	20,680	2,280	0	0	440	11,200	0	0	6,760
14e-28	Porcupine Creek	97,630	10,280	0	0	3,960	37,060	40,570	120	5,640
14e4-1	Upper Nowood	233,490	142,330	0	0	25,120	65,320	0	720	0
14e4-2	Buffalo Creek	112,960	14,400	0	0	10,080	88,440	0	40	0
14e4-3	Middle Nowood	182,670	82,470	0	0	16,760	83,440	0	0	0
14e4-4	Tensleep Creek	167,430	48,440	0	1,240	3,720	20,880	92,630	520	0
14e4-5	Bonanza	180,840	23,400	0	0	10,520	142,960	3,880	80	0
14e4-6	Paintrock Creek	245,000	29,820	0	0	11,140	88,600	115,140	300	0
14e4-7	Lower Nowood	208,980	17,200	0	0	9,080	182,180	0	520	0
14e5-1	Wood River	183,470	36,860	0	0	19,840	960	125,770	40	0

Table II-3--Surface ownership and administration (Continued)

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
		acres								
	Bighorn River Subbasin (cont'd)									
14e5-2	Upper Greybull	182,560	5,840	0	0	17,840	4,480	154,400	0	0
14e5-3	Meeteetse	212,910	147,110	0	0	24,960	34,640	6,000	200	0
14e5-4	Lower Greybull	202,930	89,610	0	0	7,200	105,560	0	560	0
14e6-1	Shoshone Plateau	111,350	0	0	0	0	0	111,350	0	0
14e6-2	Upper South Fork Shoshone	188,720	14,580	0	0	0	1,380	172,760	0	0
14e6-3	Lower South Fork Shoshone	234,810	143,050	0	0	16,920	34,120	29,680	11,040	0
14e6-5	Whistle Creek	138,180	20,520	0	0	6,240	86,700	0	24,720	0
14e6-6	Heart Mountain-Powell	249,940	167,620	0	40	10,440	43,400	0	28,440	0
14e6-7	Lovell-Kane	163,400	26,080	0	0	6,960	123,840	0	3,280	3,240
14e6-8	Sage Creek-Pryor Mountain	100,760	66,240	0	0	4,200	14,400	0	15,920	0
14e6-8a	North Lovell-Dry Creek	53,260	3,840	0	920	1,400	32,060	0	9,240	5,800
14e6a-1	Sylvan Pass	235,810	200	0	0	0	0	217,360	0	18,250
14e6a-2	Wapiti	144,130	14,080	0	0	1,000	11,960	116,890	200	0
14e6a-2a	Trout Creek	169,040	15,280	0	0	1,400	14,400	137,240	720	0
	Subtotal of 52 watersheds	7,196,060	1,781,400	250,030	2,200	370,720	3,004,850	1,514,600	228,050	44,210
	Percent of subbasin	100.0	24.8	3.5	0.1	5.1	41.7	21.0	3.2	0.6
	Percent of basin total ownership	54.6	65.3	12.8	11.0	63.4	69.9	50.5	55.3	80.5
	Clarks Fork Subbasin									
14c-1	Sunlight Basin	147,910	3,610	0	1,400	0	0	142,900	0	0
14c-2	Crandell Creek	117,640	1,260	0	0	0	0	116,380	0	0
14c-3	Clarks Fork	140,020	2,660	0	0	0	0	137,360	0	0
14c-4	Pat O'Hara	130,750	53,330	0	0	11,740	25,320	26,120	14,240	0
14c-4a	Big Sand Coulee	86,580	27,720	0	0	4,600	47,940	0	6,320	0
14c-5	Cyclone Bar	108,920	25,490	0	200	2,720	15,780	64,450	280	0
14c-6	Elk Basin	51,200	27,560	0	0	720	22,680	0	240	0
14c-7	Clarks Fork-Ruby Creek	4,180	2,760	0	0	0	1,420	0	0	0
14c-8	Upper Rock Creek	9,370	0	0	0	0	0	9,370	0	0
	Subtotal of 9 watersheds	796,570	144,390	0	1,600	19,750	113,140	496,580	21,080	0
	Percent of subbasin	100.0	18.1	0	0.2	2.5	14.2	62.4	2.6	0
	Percent of basin total ownership	6.0	5.3	0	8.0	3.4	2.6	15.7	5.1	0
	Little Bighorn Subbasin									
14e7-1	Little Bighorn River	123,520	5,240	0	1,560	0	0	116,560	0	160
14e7-2	Pass Creek	54,400	35,240	0	3,240	3,960	240	11,720	0	0
14e7-3	Lodge Grass Creek	14,950	0	0	0	0	0	14,950	0	0
14e7-4	Owl Creek	800	570	0	0	180	50	0	0	0
	Subtotal of 4 watersheds	193,670	41,050	0	4,800	4,140	290	143,230	0	160
	Percent of subbasin	100.0	21.2	0	2.5	2.1	0.1	74.0	0	0.1
	Percent of basin total ownership	1.5	1.5		24.1	0.7	0.0	4.8	0	0.3
	TOTAL	13,179,040	2,702,660	1,953,100 1/	19,960	584,340	4,426,150	3,025,590	412,350	54,890
	Percent of Total	100.0	20.5	14.8	0.2	4.4	33.6	23.0	3.1	0.4

1/ This area may include some land in private, non-Indian ownership. The BIA data for this area is 1,685,080 acres.

Land resource areas

Land resource units are geographic areas of land, usually several thousand acres in extent that are characterized by particular soil patterns (including slope and erosion), climate, water resources, land use, and type of farming. A unit may occur as one continuous area or as several separate but nearby areas and are the basic mapping unit on state land resource maps.

Major land resource areas (LRA) consist of geographically associated land resource units and are mapped and described in Agriculture Handbook 296, "Land resource regions and major land resource areas of the United States," USDA, 1965. Table II-4 lists these major land resource areas within the basin in Wyoming.

Land resource regions consist of geographically associated major land resource areas. Two of these regions--the Western Range and Irrigated Region and the Rocky Mountain Range and Forest Region are partly in this river basin.

Table II-4--Land resource regions and areas

Land resource region and area	Portion of total basin area
	--------percent---------
Western Range and Irrigated Region	
32 Northern Intermountain Desertic Basins	32
33 Semiarid Rocky Mountains	7
34 Central Desertic Plains	18
Rocky Mountain Range and Forest Region	
43 Northern Rocky Mountains	27
45 Alpine Meadows and Rockland	3
46 Northern Rocky Mountain Foothills	13

Soils

The wide variety of soils in the Wind-Bighorn-Clarks Fork River Basin is due basically to the several kinds and origins of the parent materials and to variations in climatic conditions. A generalized soils map and simplified legend is shown in figure II-5. The following paragraphs provide a general description of the soils found in each Land Resource area. The table with the map lists general descriptions of selected soil properties of dominant soils in each of the general soils areas. Each general soil area will have soil with properties not reflected in the table.

The Northern Intermountain Desertic Basins Land Resource Area comprises about 32 percent of the total basin area. Much of the land is used for grazing. The native vegetation consists mostly of desert shrubs and brush, but short and mid-grasses grow on the more favorable sites. Most of the irrigated land in the basin is in this land resource area and is used to produce hay, grain, and row crops. Elevations are 3,800 to 6,000 feet. The annual precipitation is from 5 to 14 inches. Most of these soils in the irrigated area of the Bighorn Subbasin are deep, well to poorly drained, light colored, loamy and clayey soils which formed in alluvium on flood plains, stream terraces, and alluvial fans. They are moderately to strongly alkaline, and some moderately to strongly saline. Most of these soils in the Riverton irrigated area are shallow to deep, well drained, light colored, loamy soils which formed in alluvium or residuum from interbedded shale and sandstone on gently sloping to sloping alluvial fans, stream terraces, and uplands. These soils are moderately to strongly alkaline, and some of them are moderately to strongly saline. In the nonirrigated parts of this land resource area the soils are: Deep, well drained, light colored, moderately alkaline, loamy soils which formed in alluvial deposits on nearly level to sloping high terraces; shallow to deep, well drained, light colored, moderately to strongly alkaline, loamy and clayey soils which formed in material weathered from shale on nearly level to sloping uplands; and deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy and clayey soils which formed in material weathered from shale on nearly level to sloping uplands; and deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy to clayey soils which formed in material weathered from interbedded sandstone and shale on undulating to rolling, and strongly dissected, steep uplands.

The soils in mountain areas of the basin are in three land resource areas--the Semiarid Rocky Mountains, Northern Rocky Mountains, and Alpine Meadows and Rockland. The Semiarid Rocky Mountains LRA, which comprises about 7 percent of the total basin area, is largely used for grazing. Desert shrubs, mid-grasses, and mountain shrubs cover most of this area. Small areas in isolated valleys are irrigated and used for producing hay and grain. Elevations range from 6,000 to more than 8,000 feet, and the average annual precipitation is 12 to 16 inches. Most of the soils are shallow to deep, well drained, dark colored, loamy soils which formed in materials weathered from sandstone, limestone, and dolomite on steep, strongly dissected mountain fronts with many rock outcrops and some steep canyons. Also included are some deep and shallow, well drained, light colored, loamy soils which formed in materials weathered from interbedded shale and sandstone on dissected to rough, broken uplands.

The Central Desertic Basins, Mountains, and Plateaus LRA comprise about 18 percent of the total basin area. It is used mostly for cattle and sheep grazing. The native vegetation is sagebrush, greasewood, other desert shrubs, and short and mid-grasses. Small areas along the larger streams are irrigated and used to produce hay and pasture. Elevations range from 4,500 to 7,500 feet. The annual precipitation is 7 to 12 inches. Most of the soils in this LRA are deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy to clayey soils which formed

Soil scientists obtain basic soils information.

Knowledge about his soil is essential to the successful rancher.

PLATE 3

Surface water from mountain snowmelt is diverted in the summer to irrigate croplands.

Grass or brushland range is the most extensive land use in the basin.

Forest land is defined as land at least 10 percent stocked by trees of any size.

U.S. FOREST SERVICE PHOTO

Soil associations and selected soil properties and qualities of dominant soils--Wind-Bighorn-Clarks Fork River Basin.

Map symbol	Soil association	Area percent	Components	Inclusions	Percent	Dominant soil series or family particle-size class	Position	Slope 1/ (percent)	Elevation (feet)	Mean annual soil temperature (Degrees F.)	Frost-free season (days)	Vegetation	Depth of soil (inches)	Drainage	Texture surface layer	Texture of Subsoil or Underlying layer	Permeability	Available water capacity	Shrink-swell	Reaction (pH)	Salinity	Runoff	Erosion hazard K	Erosion hazard T	Erosion hazard WEG	Potential frost action	Hydrologic group	Major land uses
C1	Cryoborolls-Cryoboralfs-Rock outcrop association	17	Cryoborolls		30	Fine-loamy	Mountains	10-30	6,900-12,495	>47	—	Shrubs and grass	40-60	Well	Loam	Loam or clay loam	Moderate	Moderate to high	Moderate	6.6-7.3	—	Rapid	.32	4	6	Moderate	B	Recreation, wildlife habitat
			Cryoboralfs		30	Fine-loamy	Mountains	30-70	7,200-13,785	>47	—	Coniferous trees	20-40	Well	Loam	Loam or clay loam	Moderate	Low to moderate	Moderate	5.6-6.5	—	Rapid	.32	3	6	Moderate	C	Recreation, wildlife habitat
			Rock outcrop		30	—	Mountains	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryochrepts 10%																								
C2	Cryoboralfs-Rock outcrop association	6	Cryoboralfs		35	Loamy-skeletal	Mountains	30-70	7,200-13,785	>47	—	Coniferous trees	20-40	Well	Very stony sandy loam	Very gravelly sandy clay loam	Moderate	Low	Moderate	5.6-6.5	—	Rapid	.17	3	3	Moderate	C	Recreation, wildlife habitat
			Rock outcrop		30	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryoborolls 20% Cryochrepts 10% Others 5%																								
C3	Cryoborolls-Rock outcrop association	11	Cryoborolls		40	Fine-loamy	Mountains	10-30	6,900-13,165	>47	—	Shrubs and grass	40-60	Well	Loam	Loam or clay loam	Moderate	Moderate to high	Moderate	6.6-7.3	—	Rapid	.32	4	6	Moderate	B	Recreation, wildlife habitat, grazing
			Rock outcrop		30	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryoboralfs 20% Others 10%																								
F1	Haplargids-Argiborolls association	3	Haplargids		40	Fine-loamy	Alluvial fans and high terraces	0-20	5,200-7,200	>47	90-120	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Moderate	Moderate	6.6-8.4	—	Slow to rapid	.32	5	6	Low	B	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Argiborolls		20	Fine-loamy	Terraces and alluvial fans	6-20	5,200-7,200	>47	90-120	Shrubs and grass	>60	Well	Sandy loam	Clay loam	Moderate	Moderate to high	Moderate	6.6-7.3	—	Medium to rapid	.24	5	3	Low	B	
				Torriorthents 10% Torrifluvents 10% Others 20%																								
F2	Haplargids-Camborthids-Torriorthents association	10	Haplargids		35	Fine-loamy	Uplands	2-15	5,200-7,200	>47	90-120	Shrubs and grass	20-40	Well	Loam	Clay loam	Moderate	Low	Moderate	6.6-8.4	—	Medium to rapid	.32	3	6	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Camborthids		25	Fine-loamy	Uplands	2-40	5,200-7,200	>47	90-120	Shrubs and grass	20-40	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	8.4-9.0	—	Medium to rapid	.37	3	4L	Low	C	
			Torriorthents		20	Loamy, shallow	Uplands	2-40	5,200-7,200	>47	90-120	Shrubs and grass	10-20	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	8.4-9.0	—	Medium to rapid	.37	2	4L	Low	D	Grazing, wildlife habitat, recreation
				Torrifluvents 10% Others 10%																								
F3	Torriorthents-Rock outcrop association	1	Torriorthents		45	Fine-loamy	Uplands	2-30	5,200-7,200	>47	90-120	Shrubs and grass	>60	Well	Loam	Loam	Moderate	High	Moderate	7.4-8.4	0-4	Medium to rapid	.28	5	6	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Rock outcrop		25	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Haplargids 10% Torrifluvents 10% Others 10%																								
F4	Haplargids-Torriorthents association	5	Haplargids		35	Fine-loamy	Uplands	3-20	5,200-7,200	>47	120-140	Shrubs and grass	20-40	Well	Sandy loam	Sandy clay loam	Moderate	Low to moderate	Moderate	6.6-8.4	—	Medium to rapid	.24	3	3	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Torriorthents		25	Fine-loamy	Uplands	1-20	5,200-7,200	>47	120-140	Shrubs and grass	>60	Well	Clay loam	Clay loam	Moderately slow	Moderate to high	Moderate	7.4-9.0	—	Medium to rapid	.37	5	6	Low	C	
				Camborthids 15% Others 15% Rock outcrop 10%																								
F9	Haplargids association	7	Haplargids		50	Fine-loamy	Alluvial fans and high terraces	0-20	6,250-7,200	47	120-140	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Moderate	Moderate	6.6-8.4	—	Slow to rapid	.32	5	6	Low	B	Grazing, wildlife habitat, irrigated hay and pasture, recreation
				Torriorthents 20% Torripsamments 20% Others 10%																								
H1	Haplargids-Torrifluvents-Torriorthents association	10	Haplargids		30	Garland	Terraces and alluvial fans	0-6	3,800-5,200	50-52	120-140	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Low to moderate	Moderate	7.4-8.4	—	Slow to medium	.32	5	6	Low	B	Irrigated cropland, grazing, wildlife habitat, recreation
			Torrifluvents		25	Youngston	Low terraces and alluvial fans	0-10	3,800-5,200	50-52	120-140	Shrubs and grass	>60	Well	Clay loam	Clay loam	Moderately slow	High	Moderate	7.4-8.4	—	Slow to medium	.37	5	4L	Low	C	
			Torriorthents		20	Apron	Alluvial fans	2-12	3,800-5,200	50-52	120-140	Shrubs and grass	>60	Well	Sandy loam	Sandy loam	Moderately rapid	Moderate	Low	7.4-8.4	—	Slow to medium	.20	5	3	Low	B	
				Fluvaquents 10% Others 15%																								
H2	Torriorthents-Camborthids association	11	Torriorthents		60	Greybull	Uplands	0-30	3,800-5,200	50-52	120-140	Shrubs and grass	20-40	Well	Clay loam	Clay loam	Moderately slow	Low to moderate	Moderate	7.4-8.4	—	Slow to rapid	.37	3	4L	Low	C	Irrigated cropland, grazing, wildlife habitat, recreation
			Camborthids		25	Pavillion	Uplands	2-20	3,800-5,200	50-52	120-140	Shrubs and grass	20-40	Well	Clay loam	Clay loam	Moderately slow	Low to moderate	Moderate	7.4-8.4	—	Slow to rapid	.37	3	4L	Low	C	
				Haplargids 10% Others 5%																								
M3	Haplargids-Natrargids-Torriorthents association	16	Haplargids		25	Saddle	Uplands	0-20	3,800-5,200	50-52	120-140	Shrubs and grass	20-40	Well	Sandy loam	Sandy clay loam	Moderate	Low to moderate	Moderate	6.6-9.0	—	Slow to rapid	.24	3	3	Low	C	Irrigated cropland, grazing, wildlife habitat, recreation
			Natrargids		15	Meeteetse	Alluvial fans	1-12	3,800-5,200	50-52	120-140	Shrubs and grass	40-60	Well	Loam	Clay	Very slow	Low	High	8.5->9.0	0-15	Rapid	.43	4	4L	Low	D	Grazing, wildlife habitat, recreation
			Torriorthents		40	Persayo	Uplands	2-45	3,800-5,200	50-52	120-140	Shrubs and grass	10-20	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	7.4-9.0	—	Slow to rapid	.37	2	4L	Low	D	Grazing, wildlife habitat, recreation
				Torrifluvents 10% Others 10%																								
M4	Camborthids-Torriorthents association	3	Camborthids		20	Gystrum	Uplands	2-20	4,500-5,200	50-52	120-140	Shrubs and grass	20-40	Well	Silty clay loam	Silty clay loam	Moderate	Low	Moderate	7.4-8.4	2-15	Rapid	.37	3	4L	Moderate	C	Grazing, wildlife habitat, recreation
			Torriorthents		50	Neville	Alluvial fans	2-30	4,500-5,200	50-52	120-140	Shrubs and grass	>60	Well	Loam	Loam	Moderate	High	Moderate	7.4-8.4	0-4	Medium to rapid	.32	5	4L	Low	C	Grazing, wildlife habitat, irrigated cropland, recreation
				Rock outcrop 15% Others 15%																								

1/ Slope range in this table applies to the total range in slope for the appropriate dominant soil.

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

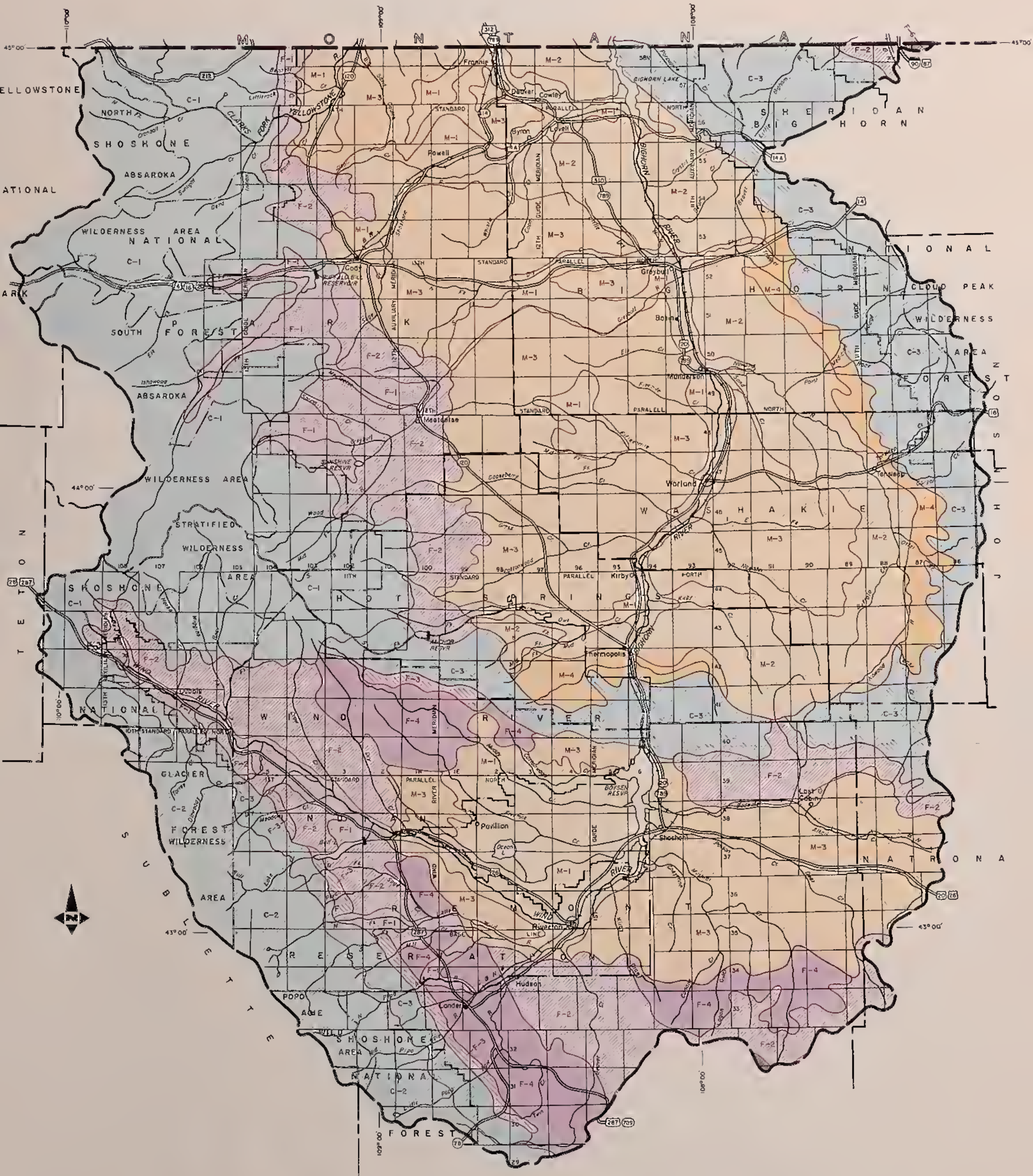
- C-1 Cryoborolls-Cryoboralfs-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.
- C-2 Cryoboralfs-Rock outcrop association: steep and very steep, shallow to deep, well-drained soils on sides and foothills of mountains.
- C-3 Cryoborolls-Rock outcrop association: steep, shallow to deep, well-drained soils on dissected mountain fronts and rounded knolls and ridges of mountains.

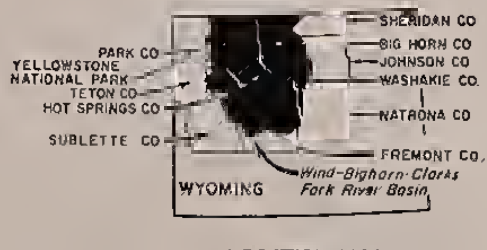
SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

- F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.
- F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.
- F-3 Torriorthents-Rock outcrop association: rolling and steep, shallow to deep, well-drained soils on mountain foot slopes.
- F-4 Haplargids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on mountain foothills and on uplands in desertic basins.
- F-5 Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills.
- F-6 Haplargids association: nearly level to rolling, deep, well-drained soils on terraces and uplands of desertic basins.

SOILS OF DESERTIC BASINS AND UPLANDS

- M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.
- M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.
- M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.
- M-4 Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected uplands in desertic basins.





LOCATION MAP

FIGURE II-5

GENERALIZED SOIL MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

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in material weathered from interbedded sandstone and shale on rolling to dissected and rough, broken uplands. There are some deep to shallow, well drained, moderately to strongly alkaline loamy soils which formed in materials weathered from red beds and thin interbedded sandstone and limestone on rolling to steep, dissected uplands; deep, excessively drained, light colored sandy soils which formed in deep, loose sands on gently sloping to dune-like uplands; and deep, well to poorly drained, light colored loamy soils which formed in alluvium on floodplains and stream terraces. These soils are moderately to strongly alkaline, and some are moderately to strongly saline.

The Northern Rocky Mountain LRA, which comprises about 27 percent of the total basin area, is largely public land with heavy forest cover. Elevations range from 6,000 to 12,000 feet. The average annual precipitation is 20 to 70 inches. Most of the soils are shallow to deep, well drained, dark colored, loamy soils. They formed in material weathered from volcanic rocks, granite, gneiss, and schist. There are many rock outcrops. In the narrow valleys the soils are deep, well to poorly drained, dark colored, gravelly, cobbly, and stony on narrow flood plains, stream terraces, and alluvial fans.

The Alpine Meadows and Rockland LRA, which comprises about 3 percent of the total basin area, is mostly public land covered with alpine grasses, herbaceous plants, and shrubs. Elevations are 10,000 feet or more. The average annual precipitation is 20 to 70 inches. The soils are shallow to deep, well drained, dark colored, loamy soils. Fifty percent or more of the area is rock outcrop.

The Northern Rocky Mountain Foothills LRA comprises about 13 percent of the total basin area. Some of the alluvial soils in the small valleys are irrigated and are used to produce grain and forage for livestock, but the area is used mainly for grazing. The vegetation is mainly short and mid-grasses and shrubs. Some of the highest areas are in forest. Elevations range from 5,000 to 7,500 feet. The annual precipitation is 12 to 20 inches. Included are: Deep, well to poorly drained, dark colored, loamy soils which formed in alluvium on flood plains, stream terraces, and alluvial fans; deep, well drained, dark colored gravelly, cobbly, and stony soils on rolling to steep glacial moraines and outwash fans and terraces; deep to shallow, well drained, light colored, loamy and clayey soils which formed in material weathered from interbedded sandstone and shale on strongly dissected, rolling to steep uplands with some rock outcrops; deep and shallow, well drained, light colored, loamy soils which formed in materials weathered from red beds, limestone, and sandy shales on rolling to steep, strongly dissected uplands with many rock outcrops.

Vegetative aspect

Vegetative aspect is a term used herein to denote a dominant type of vegetation within a mapping unit of land area. These areas are summarized in table II-5 and shown on the map of figure II-6. The vegetative aspect is dependent on elevation, soil, exposure, and rainfall, and ranges from

Table II-5--Vegetative aspects by watershed and subbasin areas

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
	Wind River Subbasin	acres								
14e-1	Upper Poison Creek	140	1,610	0	0	0	0	228,820	0	230,570
14e-3	Lower Poison Creek	10	4,390	0	0	0	0	98,680	0	103,080
14e-4	Fivemile Creek	200	12,990	320	0	26,820	0	81,820	0	122,150
14e-5	Muddy Creek	620	70,630	12,970	26,050	57,320	0	76,590	0	244,180
14e-6	Dry Muddy Creek	9,000	22,100	190	2,950	16,250	0	91,730	0	142,220
14e1-1	Upper Wind River	680	3,380	2,190	98,470	270	0	19,800	19,140	143,930
14e1-1a	Horse Creek	90	6,770	2,820	37,270	920	100	43,350	13,580	104,900
14e1-2	Wiggins Fork	80	4,600	660	70,960	540	0	20,530	46,060	143,430
14e1-3	Jakeys Fork-Torrey Creek	2,060	7,790	1,510	92,650	1,260	0	35,330	47,200	187,800
14e1-4	East Fork	40	1,090	1,290	79,050	580	0	17,100	40,440	139,590
14e1-5	Crow Creek	0	19,700	2,760	8,700	32,600	0	47,150	7,100	118,010
14e1-6	Dinwoody Creek	1,950	42,220	13,040	37,750	23,000	0	58,100	69,340	245,400
14e1-7	Bull Lake	2,690	4,950	720	14,400	26,700	0	28,750	84,980	163,190
14e1-8	Crowheart Butte-Dry	0	54,410	3,490	5,500	11,930	0	93,610	0	168,940
14e1-9	Midvale	7,060	11,140	62,070	0	15,590	40	84,640	0	180,540
14e1-10	Riverton	680	1,610	25,600	0	7,320	650	89,610	0	125,470
14e1-12	Kirby Draw	0	1,510	130	0	5,860	0	118,270	0	125,770
14e1a-1	Little Popo Agie	990	7,800	8,250	54,280	1,840	0	158,980	6,490	238,630
14e1a-2	Middle Popo Agie	1,980	8,710	13,270	62,360	6,720	0	53,220	19,860	166,120
14e1a-2a	North Popo Agie	740	15,930	5,140	6,020	16,840	0	72,930	0	117,600
14e1a-3	South Lower Little Wind	0	12,100	24,710	8,990	8,540	0	55,600	0	109,940
14e1a-4	Upper Little Wind	720	13,470	4,050	10,450	47,370	0	20,240	65,690	161,990
14e1a-4a	North Lower Little Wind	0	11,970	6,140	6,740	11,370	0	121,860	1,680	159,760
14e1a-5	Upper Beaver Creek	10	16,450	940	10,670	2,990	0	149,690	0	180,750
14e1a-6	Lower Beaver Creek	0	10,620	370	0	1,370	0	81,850	0	94,210
14e2-1	Muskrat	0	11,010	0	0	0	0	235,900	0	246,910
14e2-2	Conant Creek	60	1,050	0	0	0	0	177,210	0	178,320
14e2-3	Lower Muskrat	0	280	0	0	0	0	59,630	0	59,910
14e3-1	Alkali Creek	0	7,520	0	7,520	0	0	134,440	0	149,480
14e3-2	Upper Badwater Creek	0	2,230	1,720	14,610	0	0	115,280	0	133,840
14e3-3	Bridger Creek	20	5,150	1,060	5,660	1,730	0	104,180	0	117,8C0
14e3-4	Lower Badwater Creek	9,070	33,560	360	15,410	750	0	129,160	0	188,310
Subtotal		38,890	428,740	195,770	676,460	326,480	790	2,904,050	421,560	4,992,740

Table II-5--Vegetative aspects by watershed and subbasin areas (Continued)

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
	Bighorn River Subbasin	acres								
14e-6a	Red Canyon Creek	0	75,700	310	100	14,100	0	10,750	0	100,960
14e-7	Buffalo Creek	0	71,960	110	4,260	2,490	0	15,080	0	93,900
14e-8	Upper South Fork Owl Creek	0	44,670	0	29,040	3,890	0	3,500	0	81,100
14e-8a	Upper Owl Creek	430	83,160	12,640	18,990	27,690	0	20,790	0	163,700
14e-9	Mud Creek	0	47,910	1,310	1,280	9,660	0	18,010	0	78,170
14e-10	Candy Jack	0	0	0	540	0	170	700	0	1,410
14e-10a	East Thermopolis	0	740	0	1,230	0	0	19,720	0	21,690
14e-10b	Lucerne	0	0	4,650	1,370	0	0	18,690	0	24,710
14e-10c	Upper Hanover	0	3,330	7,950	0	0	0	26,340	0	37,620
14e-11	Kirby Creek	10	56,650	2,970	1,610	0	0	107,900	0	169,140
14e-12	No Water Creek	0	48,280	0	0	0	0	115,820	0	164,100
14e-12a	East Fork No Water Creek	0	70	0	0	0	0	100,690	0	100,760
14e-13	Gebo Mine	0	4,610	560	8,090	0	0	72,370	0	85,630
14e-14	Upper Cottonwood	0	11,890	1,160	15,870	6,110	0	90,640	0	125,670
14e-15	Gooseberry Creek	30	20,640	3,820	28,210	6,370	0	173,220	0	232,290
14e-16	Lower Cottonwood	0	650	3,000	23,480	1,830	0	147,140	0	176,100
14e-17	Colter	0	1,050	3,480	0	0	0	11,810	0	16,340
14e-17a	WA Sage	0	1,480	4,050	0	0	0	4,350	0	9,880
14e-17b	Lower Hanover	0	4,080	17,510	0	0	170	27,970	0	49,730
14e-19	Upper Fifteen Mile	0	12,250	0	1,100	2,440	0	89,810	0	105,600
14e-20	Lower Fifteen Mile	0	68,920	320	0	15,170	0	150,600	0	235,010
14e-21	Fivemile-Elk Creek	0	940	16,850	0	0	180	169,430	0	187,400
14e-22	Upper Shell Creek	220	12,830	830	60,250	0	0	94,310	0	168,440
14e-23	Lower Shell Creek	40	0	9,730	20,360	970	0	173,440	0	204,540
14e-24	Bear Creek	10	0	80	1,260	0	0	72,280	0	73,630
14e-24a	Crystal Creek	5,000	2,090	1,730	19,840	390	0	86,130	0	115,180
14e-25	Dry Creek	150	34,840	2,020	0	0	0	209,900	0	246,910
14e-26	Little Dry Creek	0	180	520	0	0	0	104,800	0	105,500
14e-27	Crooked Creek	0	420	1,080	2,960	0	0	16,220	0	20,680
14e-28	Porcupine Creek	3,650	12,820	330	38,940	0	0	41,880	0	97,620
14e4-1	Upper Nowood	30	16,720	2,580	5,910	230	0	208,020	0	233,490
14e4-2	Buffalo Creek	0	11,870	80	0	0	0	101,010	0	112,960
14e4-3	Middle Nowood	0	11,920	2,680	0	10,840	0	157,230	0	182,670
14e4-4	Tensleep Creek	540	1,640	1,880	70,320	580	30	68,750	23,690	167,430
14e4-5	Bonanza	100	12,020	3,690	17,980	0	0	147,050	0	180,840

Table II-5--Vegetative aspects by watershed and subbasin areas (Continued)

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
		acres								
	Bighorn River Subbasin (Continued)									
14e4-6	Paintrock Creek	790	7,920	5,880	81,720	690	50	125,950	22,000	245,000
14e4-7	Lower Nowood	10	26,200	3,740	0	0	80	178,950	0	208,980
14e5-1	Wood River	1,200	80,930	6,880	53,500	5,660	0	35,300	0	183,470
14e5-2	Upper Greybull	10	89,270	780	60,570	7,580	0	24,350	0	182,560
14e5-3	Meeteetse	0	44,340	10,760	5,100	0	50	152,670	0	212,920
14e5-4	Lower Greybull	130	39,040	45,230	0	0	340	118,190	0	202,930
14e6-1	Shoshone Plateau	20	43,340	0	28,340	27,720	0	11,930	0	111,350
14e6-2	Upper South Fork Shoshone	0	66,270	1,620	77,150	22,080	0	21,600	0	188,720
14e6-3	Lower South Fork Shoshone	3,940	45,560	22,020	25,930	2,090	380	134,890	0	234,810
14e6-5	Whistle Creek	0	2,900	14,800	0	0	0	120,480	0	138,180
14e6-6	Heart Mountain-Powell	230	39,780	67,950	9,300	0	830	131,850	0	249,940
14e6-7	Lovell-Kane	200	4,120	15,400	0	0	420	143,260	0	163,400
14e6-8	Sage Creek-Pryor Mountain	0	2,990	23,510	0	0	630	73,630	0	100,760
14e6-8a	North Lovell-Dry Creek	8,650	760	1,030	6,980	0	0	35,840	0	53,260
14e6a-1	Sylvan Pass	30	92,600	0	115,970	13,260	0	13,950	0	235,810
14e6a-2	Wapiti	1,520	39,820	1,240	54,700	17,820	0	29,030	0	144,130
14e6a-2a	Trout Creek	1,540	60,040	740	59,000	16,410	0	31,310	0	169,040
Subtotal		28,480	1,362,210	329,500	951,250	216,070	3,330	4,259,530	45,690	7,196,060
	Clarks Fork River Subbasin									
14c-1	Sunlight Basin	50	51,410	970	64,780	21,010	0	9,690	0	147,910
14c-2	Crandell Creek	10	39,850	300	61,470	10,700	0	5,310	0	117,640
14c-3	Clarks Fork	1,530	33,000	650	74,140	16,450	0	14,250	0	140,020
14c-4	Pat O'Hara	90	35,570	5,770	20,020	1,530	0	67,770	0	130,750
14c-4a	Big Sand Coulee	0	20,690	400	0	0	0	65,490	0	86,580
14c-5	Cyclone Bar	1,200	61,820	3,030	14,350	8,770	0	23,930	0	113,100
14c-6	Elk Basin	0	6,630	0	0	0	0	44,570	0	51,200
14c-7	Clarks Fork-Ruby Creek	(Included in 5)								
14c-8	Upper Rock Creek	0	6,270	0	550	2,180	0	370	0	9,370
Subtotal		2,880	255,240	11,120	235,310	60,640	0	231,380	0	796,570
	Little Bighorn River Subbasin									
14e7-1	Little Bighorn River	40	5,530	260*	87,160	2,850	0	27,590	90	123,520
14e7-2	Pass Creek	10	30,180	6,250*	11,830	100	10	4,910	1,110	54,400
14e7-3	Lodge Grass Creek	0	0	0	8,870	0	0	6,080	0	14,950
14e7-4	Owl Creek	0	800	0	0	0	0	0	0	800
Subtotal		50	36,510	6,510	107,860	2,950	10	38,580	1,200	193,670
Grand Total		70,300	2,082,700	542,900	1,970,880	606,140	4,130	7,433,540	468,450	13,179,040

* 100 acres dry cropland in 14e7-1; 3,970 acres dry cropland in 14e7-2. 4,070 acres included in grand total.

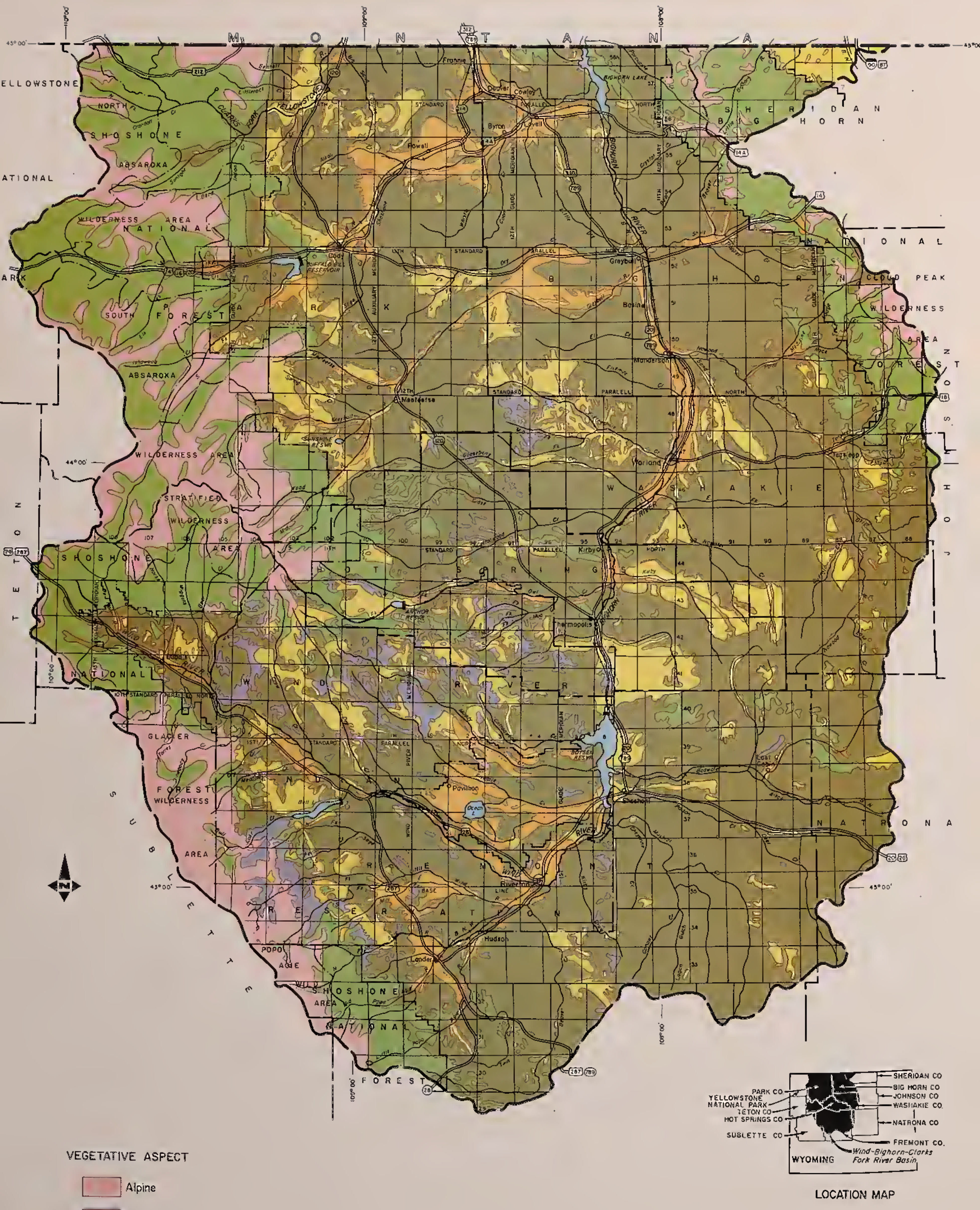

FIGURE II-6

VEGETATIVE ASPECT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

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DECEMBER 1974

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ALBERS EQUAL AREA PROJECTION

alpine in higher elevations to timber at mid-elevations to barren desert on the basin floor.

The grass aspect includes short and intermediate grasses which cover about 16 percent of the basin. It is used for cattle, sheep, and wildlife grazing.

Range conditions on grasslands are about 16 percent excellent, 56 percent good, 24 percent fair, and 4 percent poor.

Trees are the predominant vegetation on about 1,971,000 acres or about 15 percent of the basin's area. Curiously, trees are not always required for an area to be classified as forest land. 1/ Capability is the key word, and because of this, about one-fifth of the basin, or 2,301,700 acres, is classed as forest land. The ownership of forest land is shown in table II-6. For quick reference it breaks out at about 76 percent federal, 9 percent Indian, and 15 percent state and other private forests.

About 1,128,000 acres of forest are classed as noncommercial. 2/ This includes the six National Forest Wilderness and Primitive Areas, and Yellowstone National Park lands. Table II-6 will show you the area of forest land by ownership and type of forest. In table II-7 you can find the areas of forest land by ownership in each subbasin. Figure II-8 lists areas of commercial and noncommercial forest by size of timber and ownership.

Barren and brushlands are in the lower elevations on the basin floor. Most of these lands are administered by the Bureau of Land Management and are used for cattle, sheep, and wildlife grazing. Production is limited by the low rainfall. Range conditions on brushlands are 19 percent excellent, 54 percent good, 23 percent fair, and 4 percent poor.

Alpine lands are found in the higher elevations above the timber line. They are used primarily for wildlife habitat and summer range for cattle and sheep.

Nearly all the cropland in the basin is irrigated. Irrigated lands have been inventoried by types. A summary of the inventory is shown in

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1/ As used in this report, forest land is land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, land from which trees have been removed to less than 10 percent stocking, and which have not been developed for other uses, are still defined as forest lands.

2/ Commercial forest land is land which is producing or is capable of producing an economically usable harvest of wood (usually at least 20 cubic feet per acre annually) and is not withdrawn or reserved from cutting.

Table II-6 --Area of forest land by major forest type and ownership

Forest type	National Forest	Other public domain	Wind River Indian Reservation	Yellowstone National Park	State and private a/
	thousand acres				
Lodgepole pine	398.3	6.5	18.6	2/	40.0
Spruce-fir	187.2	2.1	12.5	2/	3.9
Douglas-fir	196.7	8.3	3.8	2/	67.0
Ponderosa pine	7.1	2.0	--	2/	5.9
Aspen-cottonwoods	16.9	0	0.1	2/	12.0
Whitebark-limber pine	114.0	0.3	3.1	2/	67.3
Noncommerical 2/	795.8	1.0	169.0	18.2	144.2
Total	1,716.0	20.2	207.0	18.2	340.3

a/ Estimates of forest types on private land are based on the distributions reported for state lands.
b/ Forest type distribution was not available for noncommercial land.

in table II-9. Type I are lands used for producing beans, corn, beets, potatoes, small grains, hay, pasture, and other crops. Production yields are high, water supply is adequate, and irrigation systems are generally in good condition. Type II are lands which are primarily used to produce hay and pasture. Irrigation systems are not very elaborate; land preparation, cultivation, and crop rotation are limited. Crop yields are limited by either climate, water supply, or management. Type III lands, commonly referred to as mountain meadows, are used primarily to produce native hay and pasture. Type IV lands are used to produce perennial crops which can survive for long periods without irrigation. Lands irrigated by water-spreading systems are included. Production inputs, including irrigation, are minimal. Type V lands receive water only incidentally as a result of the irrigation of other lands. The vegetation is mainly native grass used for hay and pasture. While not shown by type of irrigation, the location of major irrigated and irrigable lands is shown in figure II-7. More information is given about irrigated and irrigable lands in chapter VII.

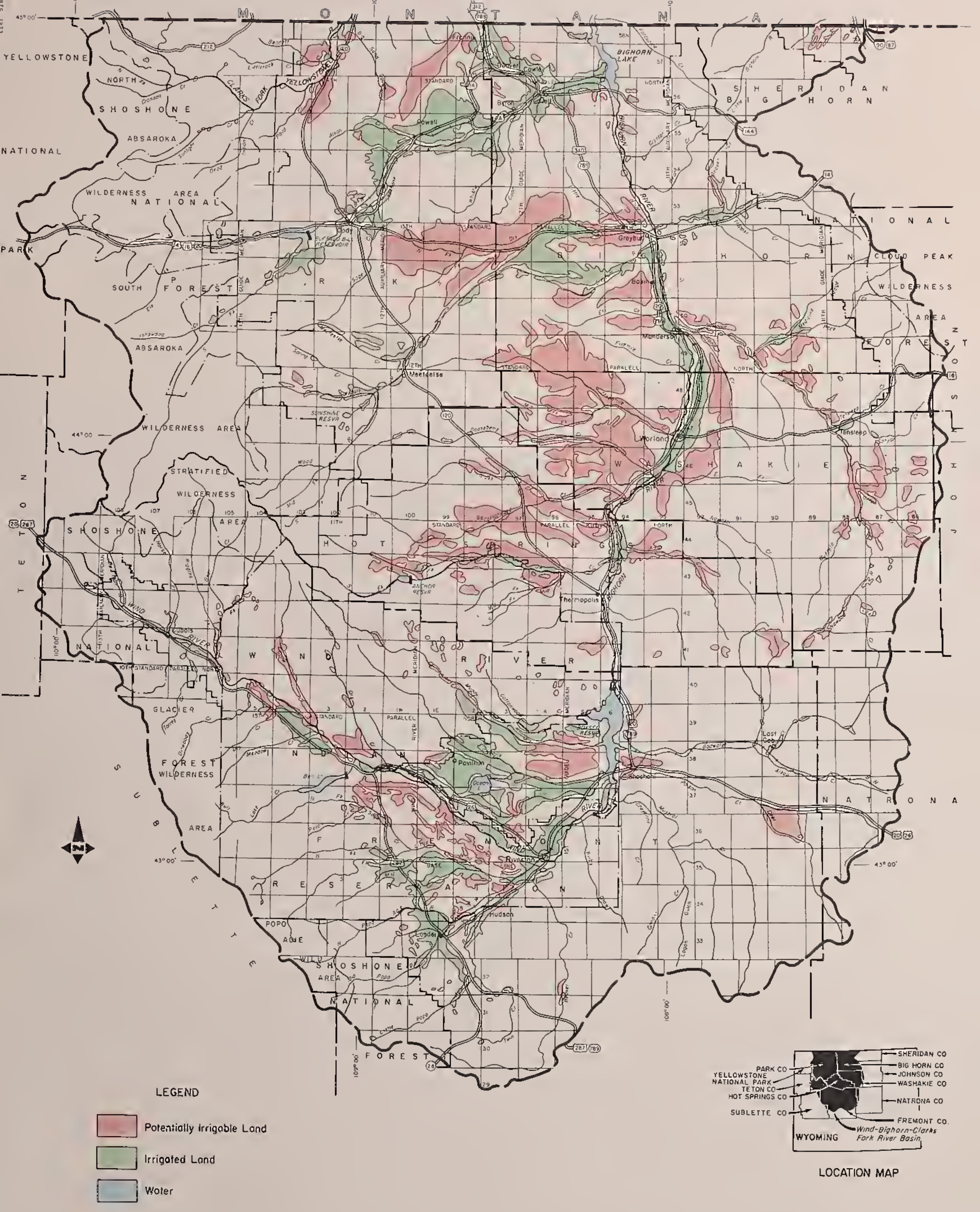

FIGURE II-7

IRRIGABLE AND IRRIGATED LAND

WIND - BIGHORN - CLARKS FORK RIVER BASIN

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ALBERS EQUAL AREA PROJECTION

Table II-7--Area of forest land by ownership and subbasin

Ownership	Total	Wind River	Bighorn River	Clarks Fork River	Little Bighorn River
	-----	-----	thousand acres	-----	-----
National Forest	1,716.0	474.4	910.0	237.4	94.2
Public Domain	20.2	8.0	12.2	0	0
Yellowstone National Park	18.2	0	18.2	0	0
Wind River Indian Reservation	207.0	207.0	0	0	0
State and private	340.3	251.9	74.4	8.1	5.9
Total	2,301.7	941.3	1,014.8	245.5	100.1

SURFACE WATER RESOURCES

There are about 70,300 surface acres of lakes, ponds, and reservoirs and 6,500 miles of creeks, streams, and rivers in the basin. Table II-10 lists these by subbasin.

The median annual volume of water leaving the State of Wyoming from the Clarks Fork, Bighorn, and Little Bighorn Rivers is approximately 3,230,800 acre-feet. In addition it is estimated that approximately 1,037,100 acre-feet of water are consumed in the production of irrigated crops. The sum of these two amounts (4,267,900 acre-feet) is an estimate of the total surface water supply available for at least half of the water years 1/ of record (50 percent chance). This yield is equivalent to about 3.9 inches of water from the entire basin area. The average annual yield per acre, however, varies from less than 0.1 inches from some low elevation areas to more than 50 inches in some mountainous areas. For example, the Shoshone River above Buffalo Bill Dam, with more than half of this area above 8,000 feet, yields an average 13.32 inches per year while Badwater Creek, with only 3 percent of its area above 8,000 feet, averages about 0.2 inches of runoff per year. For the 8 years of record on Muskrat Creek near Shoshoni, runoff averaged less than 0.02 inches. Some of the lower elevation lands yield surface water only periodically while streams and rivers originating in the mountainous areas flow all year long.

Table II-11 is a surface water budget showing estimated total water supplies and major depletions by hydrologic subareas in the basin. These data were obtained through analysis of stream gaging records supplemented by a river basin simulation model. Irrigation and phreatophyte depletion estimates are based on field and aerial photograph surveys of area and the

1/ A water year begins on October 1 of each calendar year and ends on September 30.

Table II-8--Commercial and noncommercial forest land area by stand size class and ownership, 1971

Stand size class	Ownership					
	All	National Forest	Public domain	Wind River Indian Res.	Yellowstone Nat. Park	State and private
	thousand acres					
Commercial forest						
Sawtimber	719.9	475.2	15.6	33.0	0	196.1
Poletimber	364.5	361.0	3.5	1/	0	0
Seedlings and saplings	66.1	61.0	0.1	5.0	0	0
Nonstocked	23.0	23.0	0	0	0	0
Subtotal commercial forest	1,173.5	920.2	19.2	38.0	0	196.1
Noncommercial and reserved forest 2/	1,128.2	795.8	1.0	169.0	18.2	144.2
Total forest land	2,301.7	1,716.0	20.2	207.0	18.2	340.3

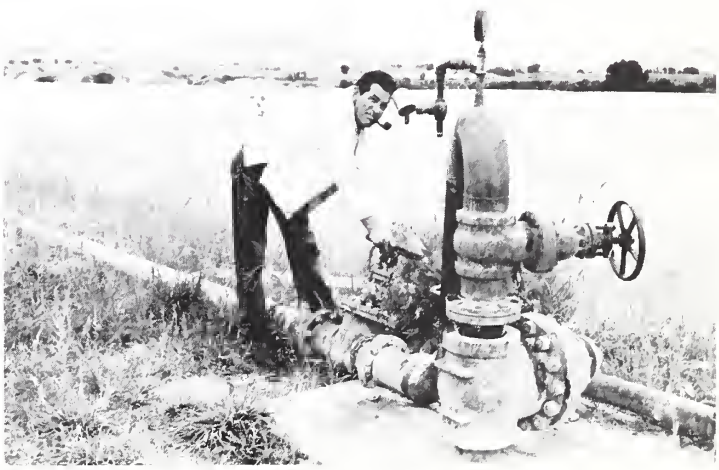
1/ Poletimber area included with sawtimber.

2/ Stand size class not available for noncommercial and reserved forest land.

PLATE 5

Water resources of the basin depend on the melting of the high country snowpack. Much of the basin presently has abundant, good quality water. U.S. FOREST SERVICE PHOTO

In some locations, the Madison Flathead formations are capable of producing large flows. This is an artesian well with over 200 pounds per square inch of pressure.



This artesian well provides water for sprinkler irrigation.

PLATE 6

Table II-9--Irrigated lands by type of irrigation, 1970

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
	Wind River Subbasin	acres					
14e-1	Upper Poison Creek	0	0	0	0	0	0
14e-3	Lower Poison Creek	0	0	0	0	0	0
14e-4	Fivemile Creek	0	0	0	320	0	320
14e-5	Muddy Creek	9,570	2,180	0	1,120	100	12,970
14e-6	Dry Muddy Creek	0	0	0	190	0	190
14e1-1	Upper Wind River	0	0	1,960	230	0	2,190
14e1-1a	Horse Creek	0	2,350	350	20	100	2,820
14e1-2	Wiggins Fork	0	660	0	0	0	660
14e1-3	Jakeys Fork-Torrey Creek	0	1,140	130	240	0	1,510
14e1-4	East Fork	0	830	80	240	140	1,290
14e1-5	Crow Creek	0	2,110	0	220	430	2,760
14e1-6	Dinwoody Creek	0	11,150	20	350	1,520	13,040
14e1-7	Bull Lake	0	680	0	0	40	720
14e1-8	Crowheart Butte-Dry Creek	0	2,630	0	420	440	3,490
14e1-9	Midvale	43,410	14,590	0	80	3,990	62,070
14e1-10	Riverton	18,250	4,080	0	70	3,200	25,600
14e1-12	Kirby Draw	0	130	0	0	0	130
14e1a-1	Little Popo Agie	0	6,190	760	10	1,290	8,250
14e1a-2	Middle Popo Agie	0	11,070	1,050	150	1,000	13,270
14e1a-2a	North Popo Agie	0	4,240	330	20	550	5,140
14e1a-3	South Lower Little Wind	200	18,170	280	1,780	4,280	24,710
14e1a-4	Upper Little Wind	0	2,560	110	480	900	4,050
14e1a-4a	North Lower Little Wind	1,730	3,360	0	610	440	6,140
14e1a-5	Upper Beaver Creek	0	680	70	190	0	940
14e1a-6	Lower Beaver Creek	0	280	0	10	80	370
14e2-1	Muskrat	0	0	0	0	0	0
14e2-2	Conant Creek	0	0	0	0	0	0
14e2-3	Lower Muskrat	0	0	0	0	0	0
14e3-1	Alkali Creek	0	0	0	0	0	0
14e3-2	Upper Badwater Creek	0	1,040	370	240	70	1,720
14e3-3	Bridger Creek	0	820	150	90	0	1,060
14e3-4	Lower Badwater Creek	0	120	0	240	0	360
	Subtotal	73,160	91,050	5,660	7,320	18,570	195,770

Table II-9--Irrigated lands by type of irrigation, 1970 (Continued)

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
	Bighorn River Subbasin	acres					
14e-6a	Red Canyon Creek	0	310	0	0	0	310
14e-7	Buffalo Creek	0	110	0	0	0	110
14e-8	Upper South Fork Owl Creek	0	0	0	0	0	0
14e-8a	Upper Owl Creek	0	10,160	80	2,300	100	12,640
14e-9	Mud Creek	0	920	0	390	0	1,310
14e-10	Candy Jack	0	0	0	0	0	0
14e-10a	East Thermopolis	0	0	0	0	0	0
14e-10b	Lucerne	1,050	3,360	0	40	200	4,650
14e-10c	Upper Hanover	6,260	1,620	0	20	50	7,950
14e-11	Kirby Creek	0	2,300	0	620	50	2,970
14e-12	No Water Creek	0	0	0	0	0	0
14e-12a	East Fork No Water Creek	0	0	0	0	0	0
14e-13	Gebo Mine	0	540	0	20	0	560
14e-14	Upper Cottonwood	0	1,120	30	10	0	1,160
14e-15	Gooseberry Creek	0	1,600	30	2,180	10	3,820
14e-16	Lower Cottonwood	780	1,870	0	340	10	3,000
14e-17	Colter	2,990	270	0	210	10	3,480
14e-17a	WA Sage	3,290	700	0	40	20	4,050
14e-17b	Lower Hanover	14,340	2,780	0	50	340	17,510
14e-19	Upper Fifteenmile	0	0	0	0	0	0
14e-20	Lower Fifteenmile	270	30	0	20	0	320
14e-21	Fivemile-Elk Creek	11,920	4,050	0	230	650	16,850
14e-22	Upper Shell Creek	0	810	10	10	0	830
14e-23	Lower Shell Creek	1,700	7,380	60	380	210	9,730
14e-24	Bear Creek	0	80	0	0	0	80
14e-24a	Crystal Creek	700	1,000	0	0	30	1,730
14e-25	Dry Creek	790	1,060	0	80	90	2,020
14e-26	Little Dry Creek	290	210	0	0	20	520
14e-27	Crooked Creek	0	700	0	370	10	1,080
14e-28	Porcupine Creek	0	330	0	0	0	330
14e4-1	Upper Nowood	0	1,420	380	780	0	2,580
14e4-2	Buffalo Creek	0	80	0	0	0	80
14e4-3	Middle Nowood	0	2,510	90	20	60	2,680
14e4-4	Tensleep Creek	0	1,800	30	40	10	1,880
14e4-5	Bonanza	0	2,730	280	430	250	3,690

Table II-9--Irrigated lands by type of irrigation, 1970 (Continued)

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
		----------	----------	----------	acres	----------	----------
	Bighorn R. Subbasin (Cont'd)						
14e4-6	Paintrock Creek	0	5,390	370	30	90	5,880
14e4-7	Lower Nowood	350	3,140	0	150	100	3,740
14e5-1	Wood River	0	5,640	460	530	250	6,880
14e5-2	Upper Greybull	0	630	20	100	30	780
14e5-3	Meeteetse	200	9,800	30	280	450	10,760
14e5-4	Lower Greybull	20,000	22,690	0	510	2,030	45,230
14e6-1	Shoshone Plateau						0
14e6-2	Upper South Fork Shoshone	0	780	840	0	0	1,620
14e6-3	Lower " " "	1,970	18,090	90	1,740	130	22,020
14e6-5	Whistle Creek	11,270	3,390	0	80	60	14,800
14e6-6	Heart Mountain-Powell	56,730	10,370	0	320	530	67,950
14e6-7	Lovell-Kane	11,570	3,600	0	180	50	15,400
14e6-8	Sage Creek-Pryor Mountain	9,100	13,180	0	720	510	23,510
14e6-8a	North Lovell-Dry Creek	150	480	0	400	0	1,030
14e6a-1	Sylvan Pass						0
14e6a-2	Wapiti	0	1,220	0	0	20	1,240
14e6a-2a	Trout Creek	0	650	0	50	40	740
	Subtotal	155,720	150,900	2,800	13,670	6,410	329,500
	Clarks Fork Subbasin						
14c-1	Sunlight Basin	0	160	810	0	0	970
14c-2	Crandell Creek	0	0	230	70	0	300
14c-3	Clarks Fork	0	0	650	0	0	650
14c-4	Pat O'Hara	2,030	3,070	270	0	0	5,370
14c-4a	Big Sand Coulee	0	400	0	0	0	400
14c-5	Cyclone Bar	540	1,450	0	1,040	0	3,030
14c-6	Elk Basin	0	0	0	0	0	0
14c-7	Clarks Fork-Ruby Creek	130	270	0	0	0	400
14c-8	Upper Rock Creek	0	0	0	0	0	0
	Subtotal	2,700	5,350	1,960	1,110	0	11,120
	Little Bighorn Subbasin						
14e7-1	Little Bighorn River	0	90	0	70	0	160
14e7-2	Pass Creek	0	1,100	800	380	0	2,280
14e7-3	Lodge Grass Creek	0	0	0	0	0	0
14e7-4	Owl Creek	0	0	0	0	0	0
	Subtotal	0	1,190	800	450	0	2,440
	Total	231,580	248,500	11,220	22,550	24,980	538,830

Table II-10--Water surface area by subbasin[1/]

Subbasin	Surface acres of lakes, ponds, and reservoirs	Miles of creeks, streams, and rivers
Wind River	38,890	1,500
Bighorn River	28,480	4,300
Clarks Fork River	2,880	600
Little Bighorn River	50	100
Total	70,300	6,500

1/ Including waters which do not provide a fishery.

Blaney-Criddle method of estimating consumptive use. Supporting data are on file with the Soil Conservation Service. Figure II-8 is a map developed in this study to show annual water yield in the basin.

Approximately 50 percent of the runoff from the basin is produced during the 4-month period from April through July. This period coincides with the melting of the mountain snowpacks and the occurrence of the general spring rains. The monthly distribution of Shell Creek flows as shown in figure II-9 is typical of the unregulated mountain drainages within the basin. About 72 percent of the annual runoff from this area comes during the April to July period. Figure II-10 is a generalized surface water flow chart for the basin.

GROUND-WATER RESOURCES

The availability of ground water within favorable drilling depths varies widely throughout the basin. In areas where ground water of suitable quality and in sufficient quantity can be obtained with a reasonable drilling depth, it may be used for domestic, municipal, industrial, irrigation, or stockwater.

Ground water along the flanks of the mountains is under artesian pressure, and flowing wells may be obtained where topographic and recharge factors are favorable. Well depths and yields vary greatly. The shales are usually not aquifers, while the sandstones are capable of supplying moderate yields of from 125 to about 300 gallons per minute (GPM). The madison limestone and flathead quartzite are capable of producing large amounts of water where they are cavernous or fractured. However, these

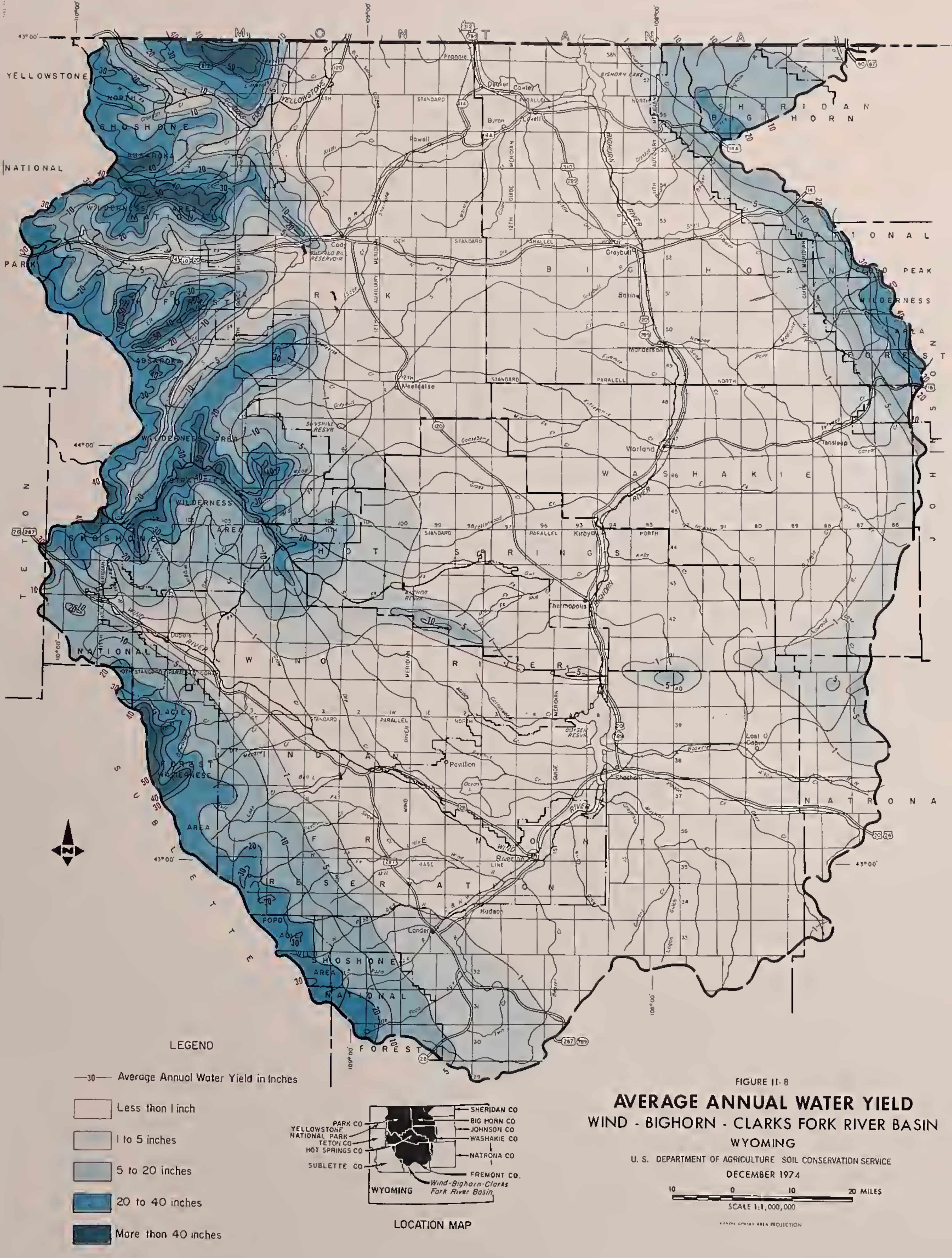


FIGURE II-8

AVERAGE ANNUAL WATER YIELD

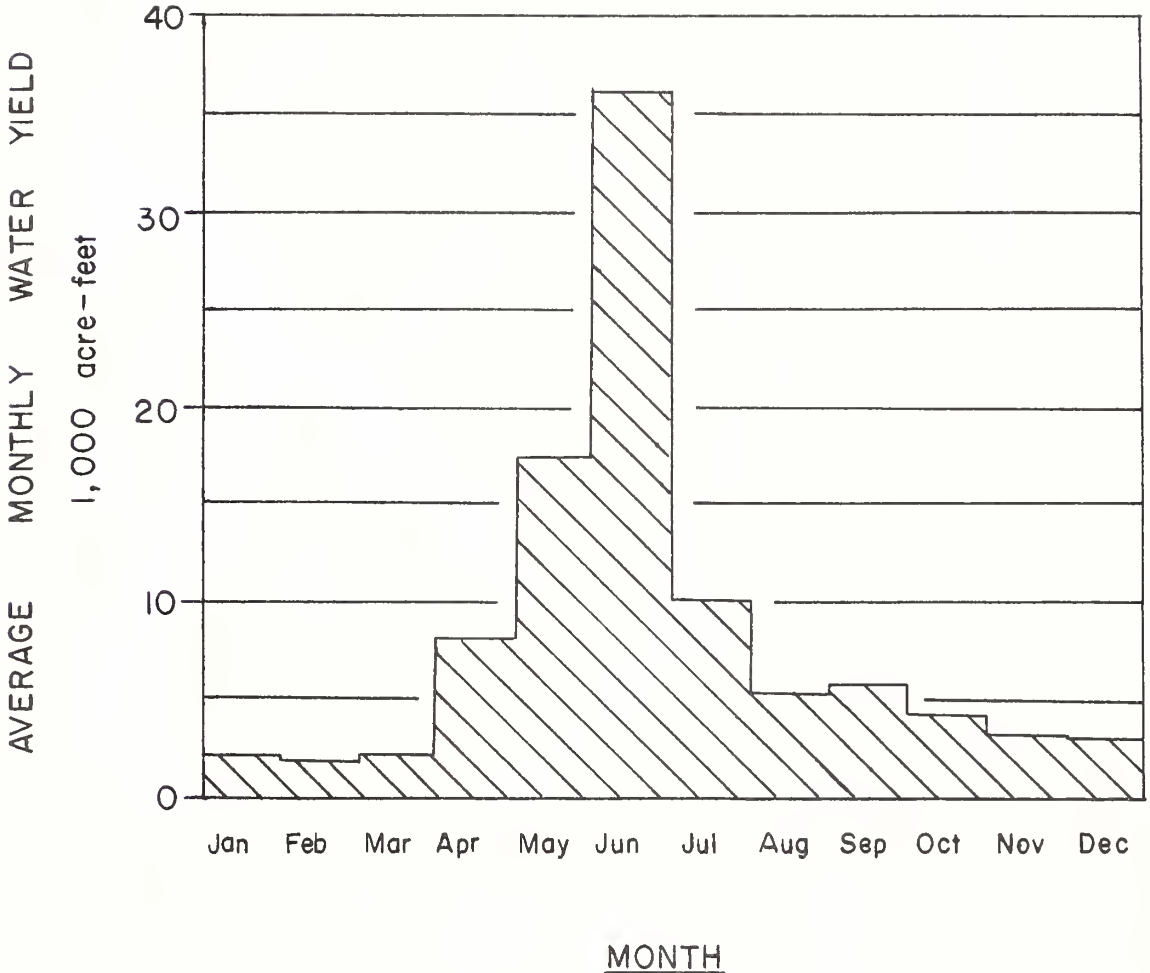
WIND - BIGHORN - CLARKS FORK RIVER BASIN

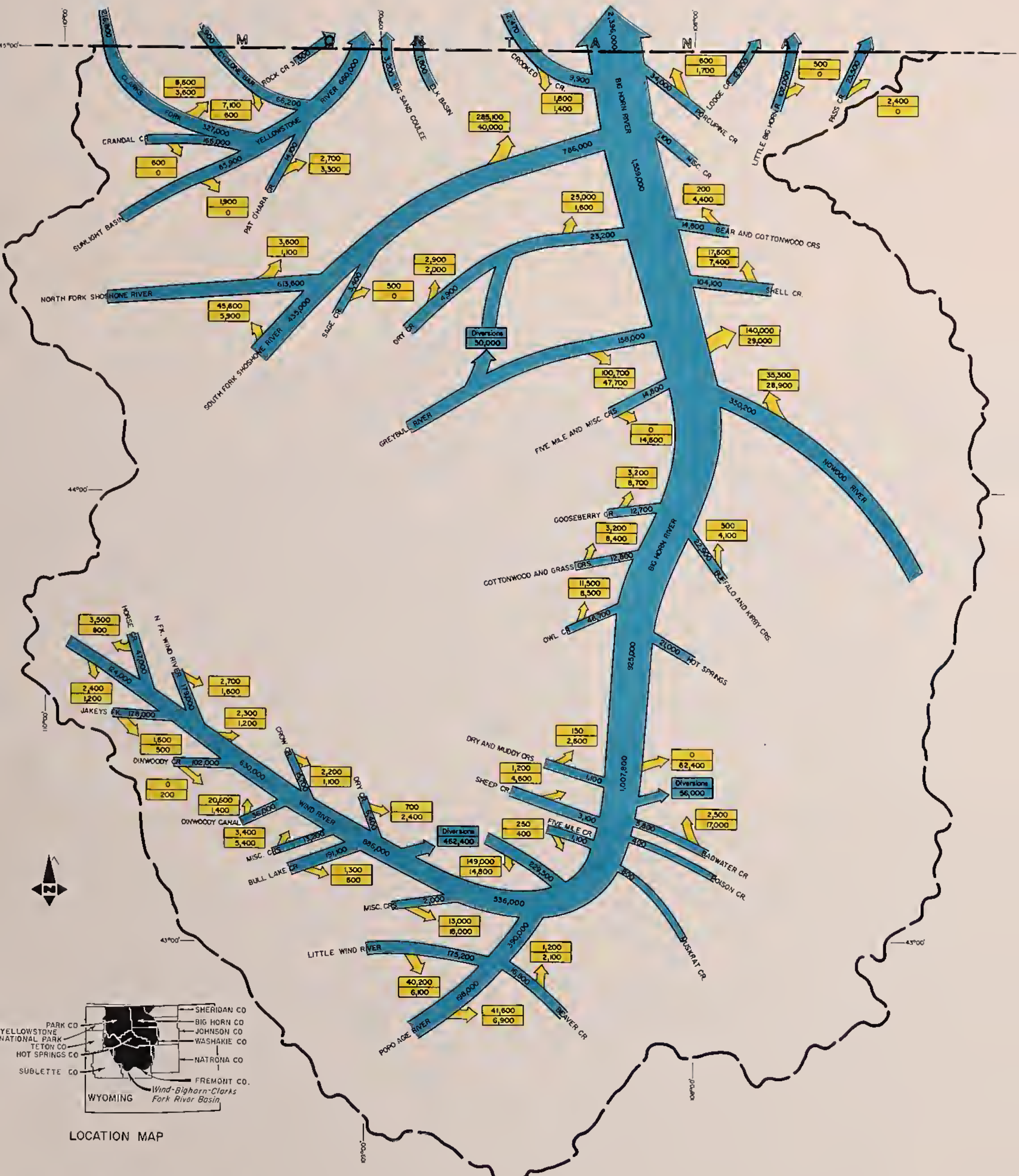
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

Figure II-9--Average monthly water yields
of Shell Creek near Shell, Wyoming





WATER YIELD & DEPLETIONS
(acre feet–50% change annual yield)

- 925,000 Water yield
- Depletion flow
- 2,700 / 1,800 Irrigation depletions / Evaporation and other losses
- Diversions 56,000 Diversion amount
- Diversion flow

FIGURE II-10

SURFACE WATER FLOW CHART

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Table II-11--Estimated surface water resources of the Wind-Bighorn-Clarks Fork River Basin in Wyoming, 1970

Hydrologic subareas or description	Watershed numbers	Phreatophyte area	Present area of irrigated land	50 percent chance: Total native water yield 1/	50 percent chance: Flow from upstream sources or transfers *	50 percent chance: Phreatophyte depletion	50 percent chance: Reservoir effects and * evaporation	50 percent chance: Available water supply	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply *	80 percent chance: Total native water yield 1/	80 percent chance: Flow from upstream sources or transfers	80 percent chance: Phreatophyte depletion	80 percent chance: Reservoir effects and evaporation *	80 percent chance: Available water supply *	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply *
		acres	acres	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet
Wind River to Boysen Reservoir																	
Wind River above Dunoir	14e1-1	860	1,996	128,100	0	1,200	0	126,900	2,900	124,000	106,100	0	1,200	0	104,900	2,900	102,000
Horse Creek	14e1-1a	560	2,423	51,300	0	800	0	50,500	3,500	47,000	47,300	0	800	0	46,500	3,500	43,000
Jakey's Fork, Torrey Ck. & misc.	14a1-3	320	1,120	180,100	0	500	0	179,600	1,600	178,000	171,100	0	500	0	170,600	1,600	169,000
North and East Fork Wind River	14e1-2,4	1,230	1,872	183,500	0	1,800	0	181,700	2,700	179,000	144,500	0	1,800	0	142,700	2,700	140,000
Dinwoody without Dinwoody Canal area	14e1-6	100	0	102,200	0	200	0	102,000	0	102,000	76,200	0	200	0	76,000	0	76,000
Mainstem Wind River above Burris	--2/	760	1,317	3,500	0	1,200	0	2,300	2,300	0	3,500	0	1,200	0	2,300	2,300	0
Subtotal for Wind River at Burris	--	3,830	8,728	648,700	0	5,700	0	643,000	13,000	630,000	548,700	0	5,700	0	543,000	13,000	530,000
Dinwoody Canal & misc. creeks	14e1-6	900	12,018	58,000	0	1,400	0	56,600	20,600	36,000	58,000	0	1,400	0	56,600	20,600	36,000
Crow Creek	14a1-5	710	1,975	19,000	0	1,100	0	17,900	2,200	15,700	14,000	0	1,100	0	12,900	2,100	10,800
Bull Lake Creek	14e1-7	380	725	193,000	0	600	0	192,400	1,300	191,100	157,000	0	600	0	156,400	1,300	155,100
Mainstem Wind River--Burris to Crowheart	--	3,240	1,958	22,000	0	5,400	0	16,600	3,400	13,200	16,900	0	5,400	0	11,500	3,400	8,100
Subtotal for Wind River at Crowheart	--	9,060	25,404	940,700	0	14,200	0	926,500	40,500	886,000	794,600	0	14,200	0	780,400	40,400	740,000
Dry Creek	14e1-8	1,460	521	9,500	0	2,400	0	7,100	700	6,400	6,500	0	2,400	0	4,100	500	3,600
Diversions to Riverton Reclamation Project	14e1-9	-	-	0	368,000 6/	-	-	368,000	5/	368,000	0	396,000 6/	-	-	396,000	5/	396,000
Returns through Pilot Wasteway	14e1-10	-	-	0	104,000	-	-	104,000	5/	104,000	0	118,400	-	-	118,400	5/	118,400
Diversions to LeClair--Riverton #2 canal	14e1-10	-	-	0	28,000	-	-	28,000	5/	28,000	0	31,000	-	-	31,000	5/	31,000
Diversions to Wyoming #2 canal	14e1-10	-	-	0	66,400	-	-	66,400	5/	66,400	0	73,800	-	-	73,800	5/	73,800
Mainstem Wind River--Crowheart to Riverton	14e1-10	9,600	7,270	9,300	25,700 3/	18,000	0	17,000	15,000	2,000	3,300	30,900 3/	18,000	0	16,200	15,000	1,200
Subtotal for Wind River above Riverton	--	20,120	33,195	959,500	332,700	34,600	0	592,200	56,200	536,000	804,400	-351,500	34,600	0	418,300	55,900	362,400
North, Middle, and Little Popo Agie	14e1a-1,2,2a	3,480	27,213	246,700	0	6,900	0	239,800	41,800	198,000	186,800	0	6,900	0	179,900	35,800	144,100
Little Wind River, Sage, Trout, and Mill Creeks	14e1a-3,4,4a	3,750	34,704	221,500	0	6,100	0	215,400	40,200	175,200	166,900	0	6,100	0	160,800	35,000	125,800
Beaver Creek	14e1a-5,6	1,270	942	20,100	0	2,100	0	18,000	1,200	16,800	13,100	0	2,100	0	11,000	900	10,000
Subtotal for Little Wind River system	--	8,500	62,859	488,300	0	15,100	0	473,200	83,200	390,000	366,800	0	15,100	0	351,700	71,700	280,000
Subtotal for Wind River at Riverton	--	28,620	96,054	1,447,800	332,700	49,700	0	1,065,400	139,400	926,000	1,171,200	351,500	49,700	0	770,000	127,600	642,400
LeClair--Riverton #2 canal	14e1-10	0	9,198	0	28,000	0	0	28,000	19,000	9,000	0	31,000	0	0	31,000	19,000	12,000
Wyoming #2 canal	14e1-10	0	11,697	0	66,400	0	0	66,400	24,000	42,400	0	73,800	0	0	73,800	24,000	49,800
Subtotal for Riverton area large canals	14e1-10	0	20,895	0	94,400	0	0	94,400	43,000	51,400	0	104,800	0	0	104,800	43,000	61,800
Adjustment for return flows above Riverton included in "Mainstem Wind River-Crowheart to Riverton" above	14a1-10	-	-	-	25,700	-	-	25,700	-	25,700	-	30,900	-	-	30,900	-	30,900
Fivemile Creek and Hurley Draw	14e-4	570	316	2,250	0	900	0	1,350	250	1,100	1,600	0	900	0	700	200	500
Sheep and Muddy Creeks	14e-5	3,050	1,484	9,100	0	4,800	0	4,300	1,200	3,100	7,600	0	4,800	0	2,800	800	2,000
Dry, Muddy, & Cottonwood Creeks	14e-6	1,640	187	3,850	0	2,600	0	1,250	150	1,100	2,900	0	2,600	0	300	100	200
Riverton Reclamation Project and Ocean Lake	14e1-9	7,290	73,562	0	264,000	14,800	0	249,200	149,400	99,800	0	277,600	14,800	0	262,800	149,400	113,400
Diversions (natural & artificial): Mainstem Riverton to Boysen	--	-	-	-	56,000	-	-	56,000	-	56,000	-	49,800	-	-	49,800	-	49,800
Mainstem Wind River--Riverton to Boysen	--	22,600 7/	132	0	56,000	55,700	0	300	300	0	0	49,800	49,500	0	300	300	0
Kirby Draw and Muskrat Creek	14a1-12 14a2-1,2,3	1,720	0	2,000	0	1,200	0	800	0	800	1,600	0	1,200	0	400	0	400
Poison Creek	14e-1,3	2,150	0	1,900	0	1,500	0	400	0	400	1,700	0	1,500	0	200	0	200
Badwater Creek	14e3-1,2,3,4	8,380	3,139	25,300	0	17,000	0	8,300	2,500	5,800	20,700	0	17,000	0	3,700	1,400	2,300
Subtotal for Wind River above Boysen Reservoir	--	76,020	195,769	1,492,200	0	148,200	0	1,344,000	336,200	1,007,800	1,107,300	0	142,000	0	1,065,300	322,800	742,500

Table II-11--Estimated surface water resources (Continued)

Hydrologic subareas or description	Watershed numbers	Phreato-phyte area	Present area of irrigated land	50 percent chance: Total native water yield 1/	Flow from upstream sources or transfers	Phreato-phyte depletion	Reservoir effects and evaporation	Available water supply	Irrigation depletion	Remaining water supply	80 percent chance: Total native water yield 1/	Flow from upstream sources or transfers	Phreato-phyte depletion	Reservoir effects and evaporation	Available water supply	Irrigation depletion	Remaining water supply
		--acres--		--acre-feet--							--acre-feet--						
Boysen Reservoir evaporation	-	-	-	-	-	-	47,600	47,800	-	47,800	-	-	-	42,500	42,500	-	42,500
Boysen Reservoir change in storage	-	-	-	-	-	-	35,000	35,000	-	35,000	-	-	-	40,000	40,000	-	40,000
Total for Wind River below Boysen Reservoir	-	76,020	195,769	1,492,200	0	148,200	82,800	1,261,200	336,200	925,000	1,207,300	0	142,000	2,500	1,062,800	322,800	740,000
Bighorn River from Boysen to Kane																	
Owl, Mud, and Red Canyon Creeks	14e-6a, 8, 8a, 9, 10, 10b, 13	6,400	15,678	66,500	0	8,500	0	58,000	11,300	46,700	48,500	0	8,500	0	40,000	7,800	32,200
Buffalo, Kirby, & Nowater Creeks	14e-7, 11, 12, 12a	2,560	384	27,300	0	4,100	0	23,200	300	22,900	17,200	0	4,100	0	13,100	200	12,900
Cottonwood and Grass Creeks	14e-14, 16	5,890	2,918	22,400	0	6,400	0	16,000	3,200	12,800	16,400	0	6,400	0	10,000	2,400	7,600
Gooseberry Creek	14e-15	6,850	3,818	24,600	0	8,700	0	15,900	3,200	12,700	18,700	0	8,700	0	10,000	2,200	7,800
Fifteen, Five Mile, & Elk Creeks	14e-17, 19, 20, 21	9,470	0	29,400	0	14,600	0	14,800	0	14,800	22,000	0	14,600	0	7,400	0	7,400
Nowood River	14e4-1 to 7	11,460	19,167	414,400	0	28,900	0	385,500	35,300	350,200	355,600	0	28,900	0	326,700	34,100	292,600
Greybull River	14e5-1 to 4	17,980	51,388	306,400	0	47,700	0	285,700	100,700	158,000	235,000	0	47,700	0	187,300	78,300	109,000
Dry Creek above Bench Canal	14e-25, 26	1,080	1,163	9,800	0	2,000	0	7,800	2,900	4,900	6,300	0	2,000	0	4,300	2,900	1,400
Diversions to Dry Creek	14e5-4	-	-	-	50,000	-	-	50,000	-	50,000	-	50,000	-	-	50,000	-	50,000
Dry Creek below Bench Canal	14e5-4	970	12,705	-	50,000	1,800	0	48,200	25,000	23,200	-	50,000	1,800	-	48,200	25,000	23,200
Shell Creek	14e-22, 23	4,100	10,493	129,100	0	7,400	0	121,700	17,600	104,100	109,200	0	7,400	0	101,800	16,400	85,400
Bear Creek to Cottonwood Creek	14e-24, 24a	4,480	78	19,400	0	4,400	0	15,000	200	14,800	17,400	0	4,400	0	13,000	200	12,800
Thermopolis Hot Springs	14e-10a	-	-	21,000	0	0	0	21,000	0	21,000	21,000	0	0	0	21,000	0	21,000
Mainstem Bighorn River	14e-10c, 17a, 17b, et. al.	16,000	61,579	66,900	0	29,000	0	37,900	140,000	102,100 8/	62,700	0	29,000	0	33,700	140,000	106,300 8/
Subtotal for Bighorn Basin	--	87,240	179,371	1,137,200	0	163,500	0	973,700	339,700	634,000	930,000	0	163,500	0	766,500	309,500	457,000
Total for Wind-Bighorn Basin at Kane	--	163,260	375,140	2,629,400	0	311,700	82,800	2,234,900	675,300	1,559,000	2,137,300	0	305,500	-2,500	1,829,300	632,300	1,197,000
Shoshone River																	
North Fork Shoshone River	14e6a-1, 2, 2a	1,420	1,977	629,500	0	1,100	11,000	617,400	3,800	613,600	521,000	0	1,100	11,000	508,900	3,800	505,100
South Fork Shoshone River	14e6-1, 2, 3	7,620	23,641	497,500	0	5,900	11,000	480,600	45,600	435,000	413,000	0	5,900	11,000	396,100	45,600	350,500
Sage Creek near Cody	14e6-3	0	408	3,900	0	0	0	3,900	500	3,400	2,500	0	0	0	2,500	400	2,100
Lower Shoshone River	14e6-5,6,7,8,8a	21,940	122,698	41,610	17,490	40,000	0	19,100	285,100	266,000 9/	37,120	11,280	30,000	0	18,400	285,100	266,700 9/
Subtotal for Shoshone River	--	30,980	148,724	1,172,510	17,490	47,000	22,000	1,121,000	335,000	786,000	973,620	11,280	37,000	22,000	925,900	334,900	591,000
Total for Wind-Bighorn-Shoshone Rivers at Kane	--	194,240	523,864	3,801,910	17,490	358,700	104,800	3,355,900	1,010,900	2,345,000	3,110,920	11,280	342,500	24,500	2,755,200	967,000	1,788,000
Crooked Creek	14e-27	510	1,079	630	12,470	1,400	0	11,700	1,800	9,900	450	8,650	1,400	0	7,700	1,600	6,100
Porcupine Creek	14e-28	640	329	36,300	0	1,700	0	34,600	600	34,000	29,300	0	1,700	0	27,600	600	27,000
Local inflow Kane to state line	14e-24a, 27, 28	-	-	7,100	0	0	0	7,100	0	7,100	5,900	0	0	0	5,900	0	5,900
Total for Wyoming portion Bighorn River Basin at state line	--	195,390	525,272	3,845,940	29,960	361,800	104,800	3,409,300	1,013,300	2,396,000	3,146,570	19,930	345,600	24,500	2,796,400	969,400	1,827,000
Clarks Fork of Yellowstone																	
Crandall Creek	14c-2	0	303	166,600	0	0	0	166,600	600	166,000	142,800	0	0	0	142,800	600	142,200
Sunlight Basin area	14c-1	0	967	87,800	0	0	0	87,800	1,900	35,900	75,200	0	0	0	75,200	1,900	73,300
Cyclone Bar	14c-5	320	3,679	60,200 10/	13,900	800	0	73,300	7,100	66,200	52,200 10/	11,900	800	0	63,300	7,100	56,200
Pat O'Hara Creek	14c-4	1,280	1,595	20,100	0	3,300	0	16,800	2,700	14,100	17,700	0	3,300	0	14,400	2,600	11,800
Clarks Fork	14c-3, 6, 7	1,410	4,575	123,400 10/	216,800	3,600	0	336,600	8,800	327,800	111,600 10/	177,300	3,600	0	285,300	8,800	276,500
Subtotal for mainstem Clarks Fork at state line	--	3,010	11,119	458,100	230,700	7,700	0	681,100	21,100	660,000	399,500	189,200	7,700	0	581,000	21,000	560,000

Table II-11--Estimated surface water resources (Continued)

				50 percent chance								80 percent chance						
Hydrologic aubareas or description	Watershed numbers	Phreato-phyte area	Present area of irrigated land	Total native water yield 1/	Flow from upstream sources or transfers	Phreato-phyte depletion	Reservoir effects and evaporation	Available water supply	Irrigation depletion	Remaining water supply	Total native water yield 1/	Flow from upstream sources or transfers	Phreato-phyte depletion	Reservoir effecta and evaporation	Available water supply	Irrigation depletion	Remaining water supply
		acres	acres	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet
Upper Rook Creek in Wyoming	14c-8	0	0	31,500	0	0	0	31,500	0	31,500	26,000	0	0	0	26,000	0	26,000
Big Sand Coulee in Wyoming	14c-4a	0	0	3,200	0	0	0	3,200	0	3,200	2,200	0	0	0	2,200	0	2,200
Elk Basin	14c-6	0	0	1,800	0	0	0	1,800	0	1,800	1,300	0	0	0	1,300	0	1,300
Total for Clarks Fork Baain in Wyoming	--	3,010	11,119	494,600	230,700	7,700	0	717,600	21,100	696,500	429,000	189,200	7,700	0	610,500	21,000	589,500
Little Bighorn River																	
Lodge Grass Creek in Wyoming	14e7-3	0	0	12,800	0	0	0	12,800	0	12,800	10,300	0	0	0	10,300	0	10,300
Upper Little Bighorn River	14e7-1	0	163	102,300	0	0	0	102,300	300	102,000	82,300	0	0	0	82,300	300	82,000
Paaa Creek in Wyoming	14e7-2	0	2,278	25,900	0	0	0	25,900	2,400	23,500	20,900	0	0	0	20,900	2,000	18,900
Total for Little Bigborn River	--	0	2,441	141,000	0	0	0	141,000	2,700	138,300	113,500	0	0	0	113,500	2,300	111,200
Total for Wind-Bighorn-Clarks Fork leaving Wyoming	--	198,400	538,832	4482,090	260,110	369,500	104,800	4,267,900	1,037,100	3,230,800	3,689,430	208,770	353,300	24,500	3,520,400	992,700	2,527,700

1/ Except that flow required to supply evaporation from flowing streama or small lakes and ponds is not estimated. For the purpose of this table, riparian phreatophytes are considered part of the stream aystem, though partly supplied by inflowing ground water.
2/ -- means no number is needed.
3/ Includea return flows from Riverton #2 and Wyoming #2 canals.
4/ - means no number applies
5/ A more detailed water budget for theae areas is included below.
6/ A negative sign (-) denotea a diversion or transfer. A plus (+) sign denotes return flowa. Native surface water yields for these areas are included in other areas listed in the table.
7/ Includes some areas not mapped because of identification problems on aerial photographs.
8/ Supplied from Boysen Reservoir from Wind River streamflows.
9/ Supplied from Buffalo Bill Reservoir from North and South Fork Shoshone River streamflows.
10/ Includes flows from Montana portions of watersheds 14c-3 and 14c-5.

*Numbers in thaaa columns may represent either increasing or decreasing effects according to the description in the first column in the table.

formations are usually deeply buried and may be encountered within favorable drilling depths only along a narrow band at the base of the mountains and along the associated structures. Flowing wells of up to 7 cubic feet of water per second have been reported from these formations.

Figure II-11 shows the general availability of ground water. It shows the depth within which ground water may be expected and the amount of ground water that may be expected from wells within certain areas. This map is generalized, and consequently, does not show local detail. Therefore, proposals for individual wells should be evaluated by a qualified person to determine ground-water potential at specific sites. Another part of this figure shows the locations of areas covered by existing ground-water reports.

FISH AND WILDLIFE RESOURCES

Low human population density, large amounts of public lands, wide variations in climate and elevation are factors which provide varied and plentiful wildlife habitat. The impacts on fish and wildlife resources must be carefully considered when planning the conservation and development of other resources.

Big game habitat

The habitat for big game animals ranges from alpine peaks to grasslands-sagebrush plains, irrigated croplands, and deserts. Table II-12 lists big game species and the estimated extent of their habitat in the basin. This information has been compiled from the Wyoming Game and Fish Commission Planning Reports.

Figure II-12 is a series of maps showing areas and value of habitat for deer, antelope, elk, moose, bighorn sheep, mountain goat, and bear within the basin. These maps are taken from the Missouri River Basin Comprehensive Framework Study report on fish and wildlife tentative needs and problems in the Yellowstone River Subbasin.

The condition of big game habitat is generally good with the most serious limitation being winter range for elk, moose, and deer. Population estimates of basic herd numbers for the winter carry-over are shown in table II-13. Also listed are 1969 harvest estimates.

Upland and small game habitat

Upland game habitat varies from forested mountains to sagebrush-grassland plains. Most of the habitat lands are also utilized for livestock range. Table II-14 lists estimated areas of habitat and the 1969 harvest of species of upland game.

Figure II-13 is a series of maps from the Missouri River Basin Comprehensive Framework Study showing areas and quality of habitat for pheasant, turkey, sharp-tailed grouse, mountain grouse, (blue and ruffed grouse),

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

WYOMING PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450 gpm	Fair to Good
TERTIARY	Miocene		Miocene & Oligocene Rocks	Water Bearing Properties Unknown		
TERTIARY	Oligocene		*Intrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Oligocene		Extrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Eocene		Upper & Middle Eocene Rocks	Water Bearing	Less than 50 gpm	Good
TERTIARY	Eocene		Wind River Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Eocene		Wasatch Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Paleocene		Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		Lance & Meeteetse Formation	Water Bearing	Less than 50 gpm	Fair
CRETACEOUS	UPPER		Mesaverde Group	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER	COLORADO GROUP	*Cody Shale	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	Frontier Formation	Water Bearing	*** Less than 50 gpm	Poor
CRETACEOUS	LOWER	COLORADO GROUP	*Mowry & Thermopolis Shales	Non-Water Bearing		
CRETACEOUS	LOWER		Cloverly & Morrison Formations	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Sundance Formation	Water Bearing	*** Less than 50 gpm	Poor
JURASSIC			*Gypsum Spring Formation	Non-Water Bearing		
TRIASSIC			Chugwater Formation	Non-Water Bearing		
TRIASSIC			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN			Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN			*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
CAMBRIAN			Gros Ventre Formation	Non-Water Bearing		
CAMBRIAN			*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

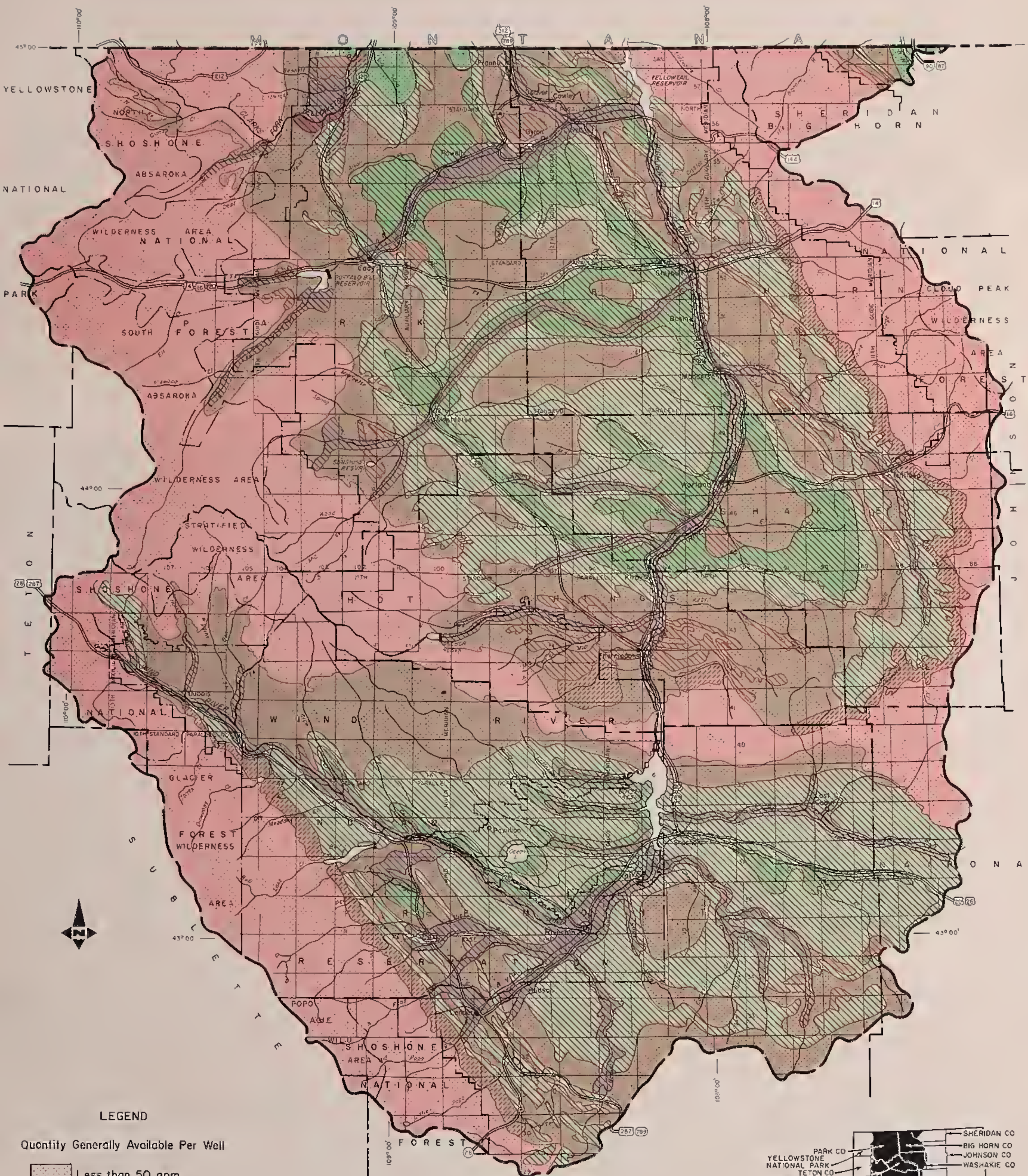
* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

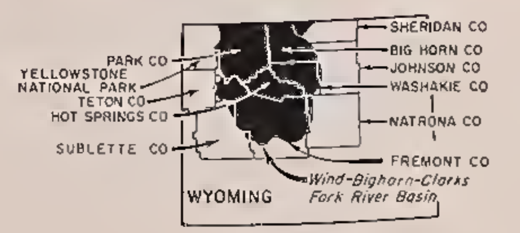
** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1978
M7-N-22780G-2





LOCATION MAP

FIGURE II-11

GENERAL AVAILABILITY OF GROUND WATER

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

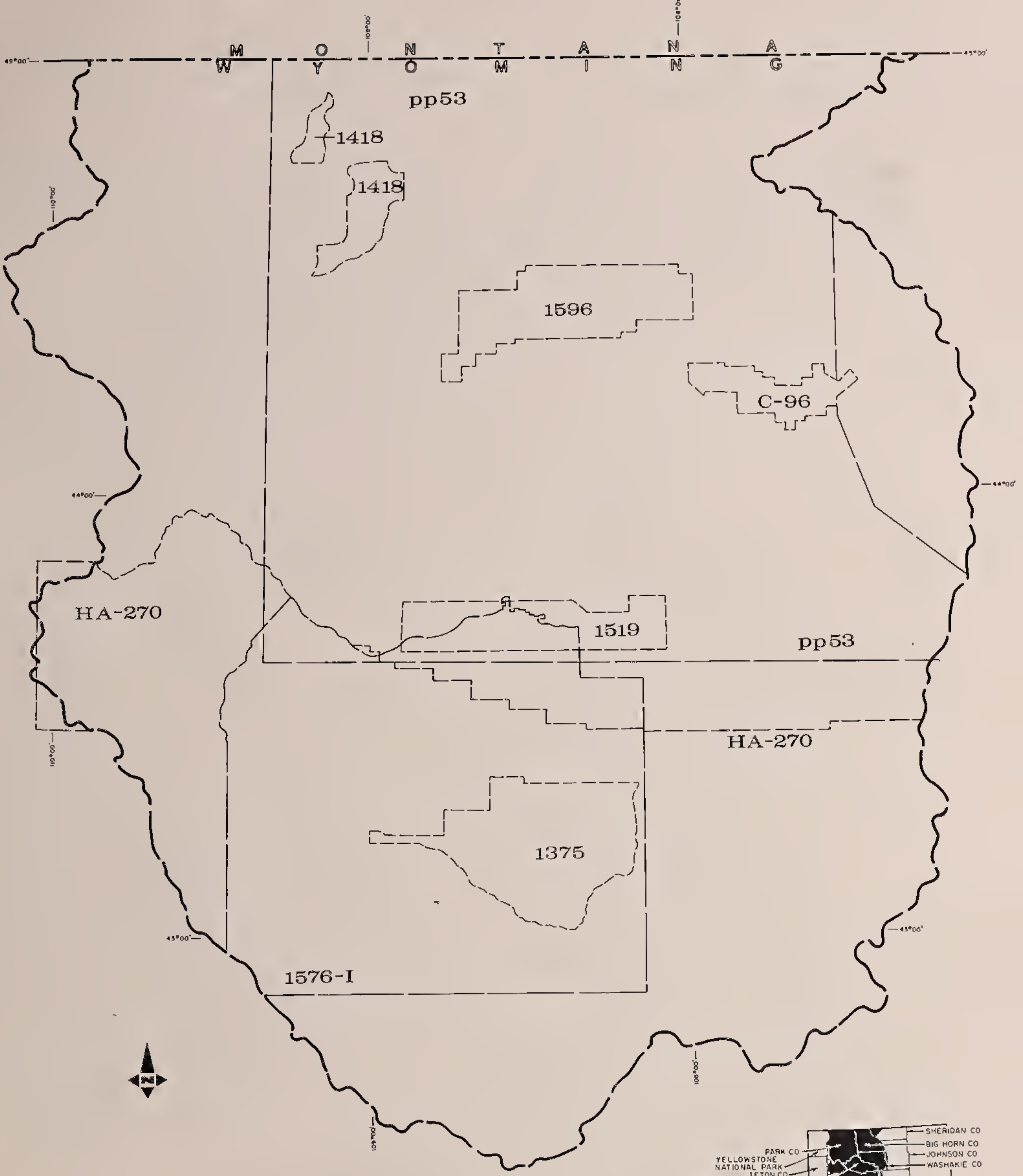
DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

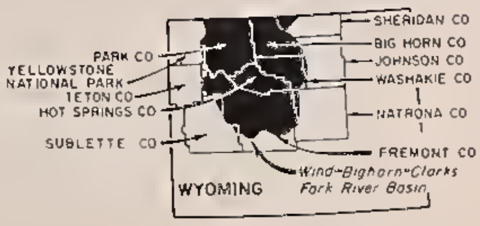
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE



BIBLIOGRAPHY OF GROUND WATER AND RELATED STUDIES

WYOMING

1596	USGS Water Supply Paper 1596, Geology and Ground Water Resources of the Greybull River - Dry Creek Area, Wyoming; C.J. Rabinove and R.H. Langford.
1519	USGS Water Supply Paper 1519, Geology and Ground Water Resources of the Owl Creek Area, Hot Springs County, Wyoming; D.W. Darry and R.T. Littleton.
1418	USGS Water Supply Paper 1418, Geology and Ground Water Heart Mountain and Chapman Dench Divisions, Shoshone Irrigation Project, Wyoming; H.A. Swenson.
1375	USGS Water Supply Paper 1375, Ground Water Resources of Riverton Irrigation Project Area, Wyoming; D.A. Morris, O.M. Hackett, K.E. Vanlier, and E.A. Moulder.
1576-I	USGS Water Supply Paper 1576-I, Ground Water Resources of the Wind River Indian Reservation, Wyoming; L.J. McGreavy, W.G. Hodson, and S.J. Rucker.
pp53	USGS Professional Paper 53, 1906; Geology and Water Resources of the Bighorn Basin, Wyoming; C.A. Fisher.
C-96	USGS Circular 96, Ground Water Resources of the Paintrock Irrigation Project, Wyoming; F.A. Swenson and W.K. Bach.
HA-270	U.S. Geological Hydrologic Atlas 270, Ground Water Resources and Geology of the Wind River Dasin Area, Central Wyoming; H.A. Witcomb and M.E. Lowry.



LOCATION MAP

AREAS COVERED BY GROUND WATER REPORTS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

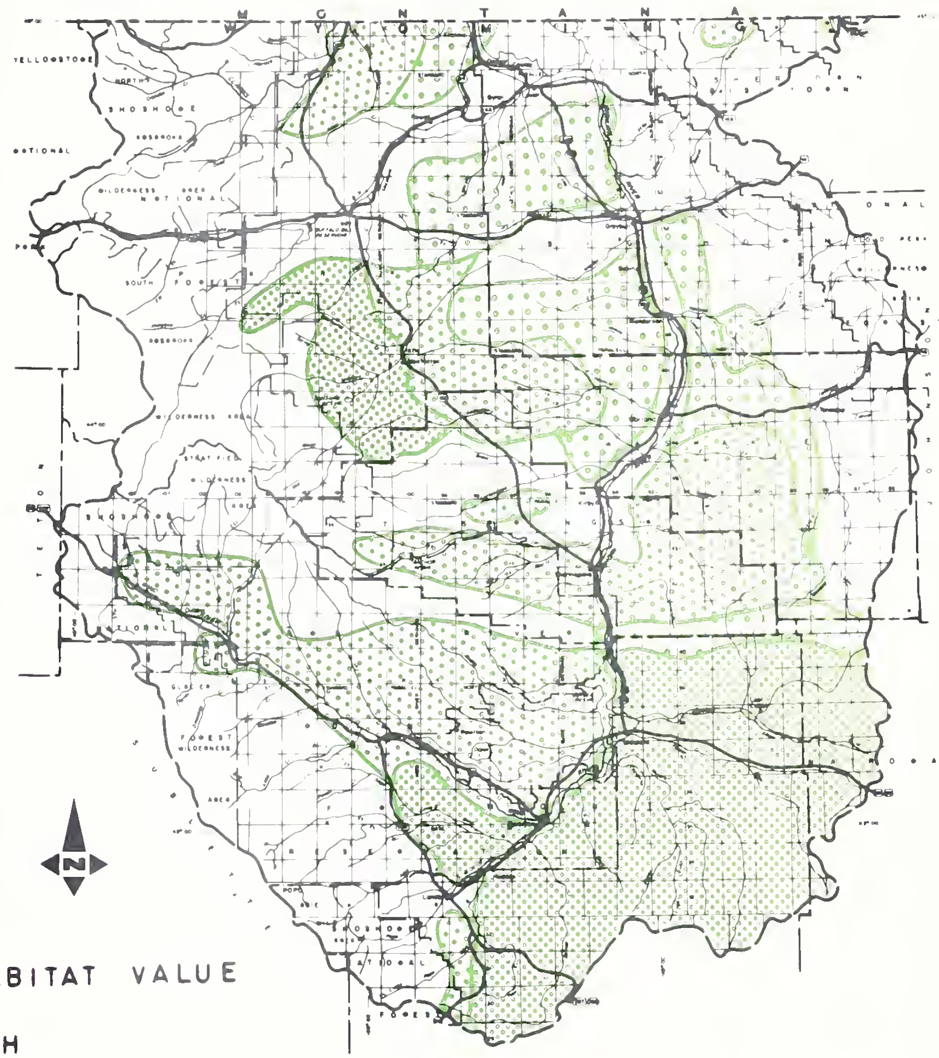
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

M7-N-22780G-1



ANTELOPE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975

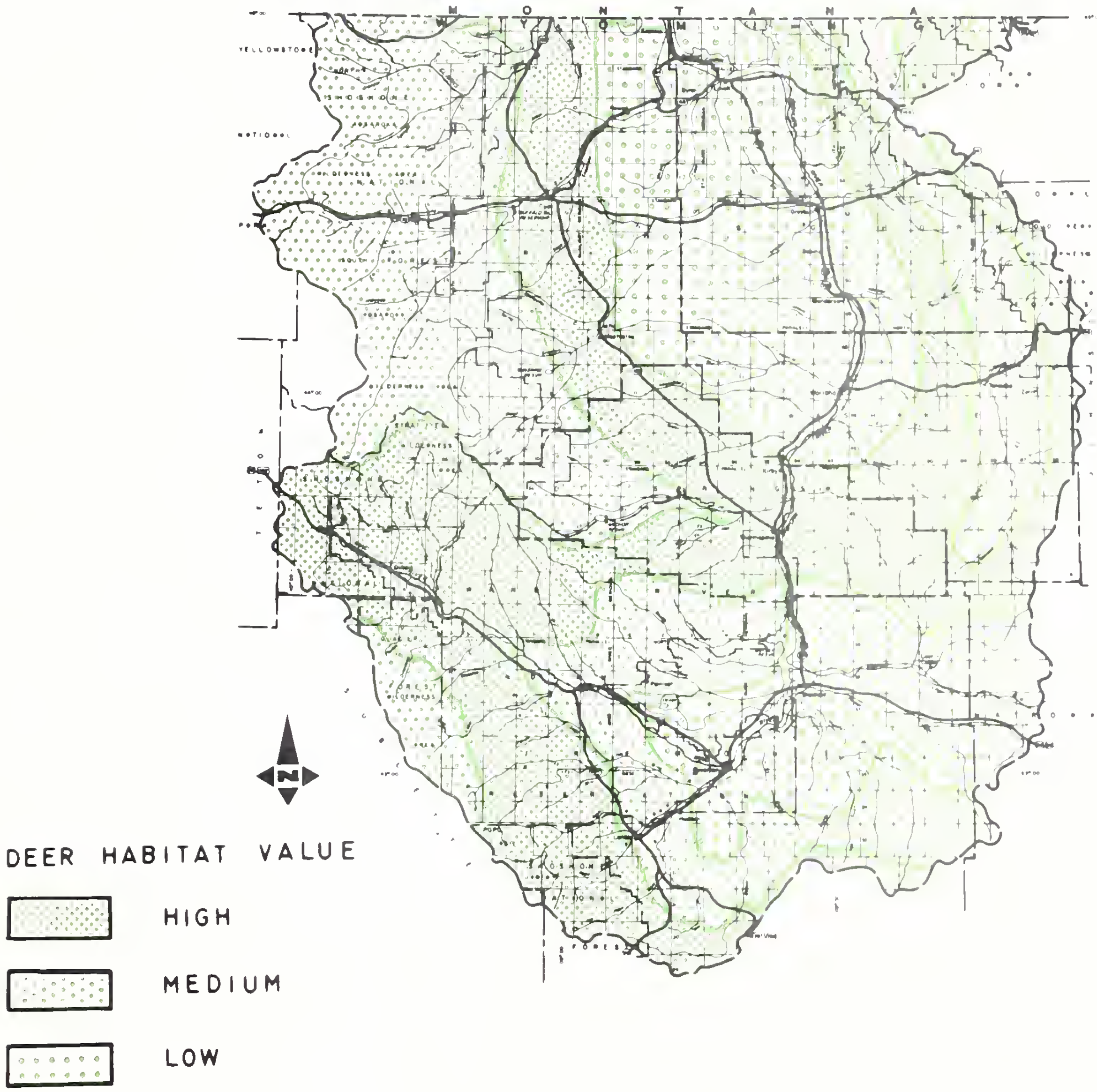


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

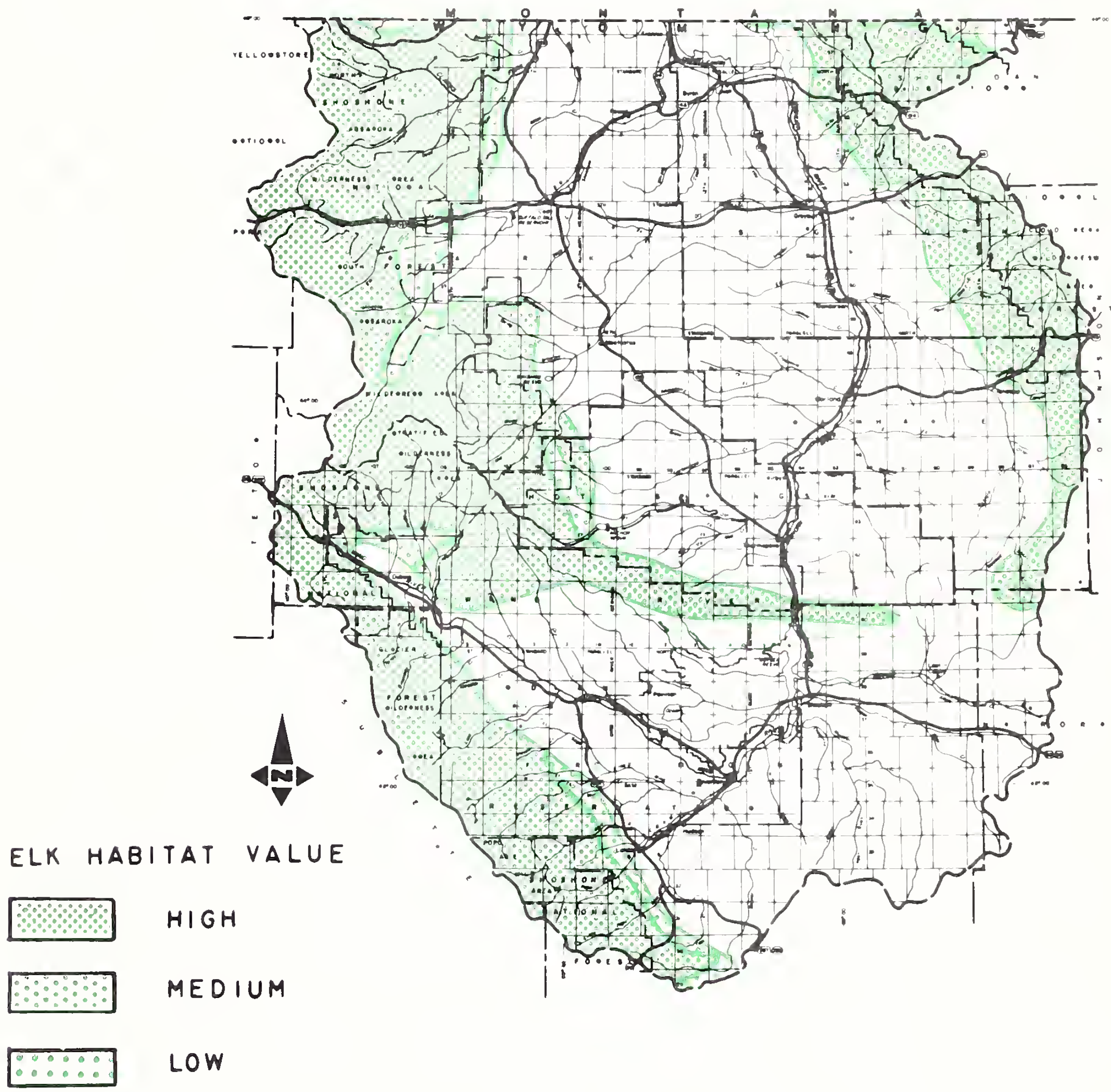


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

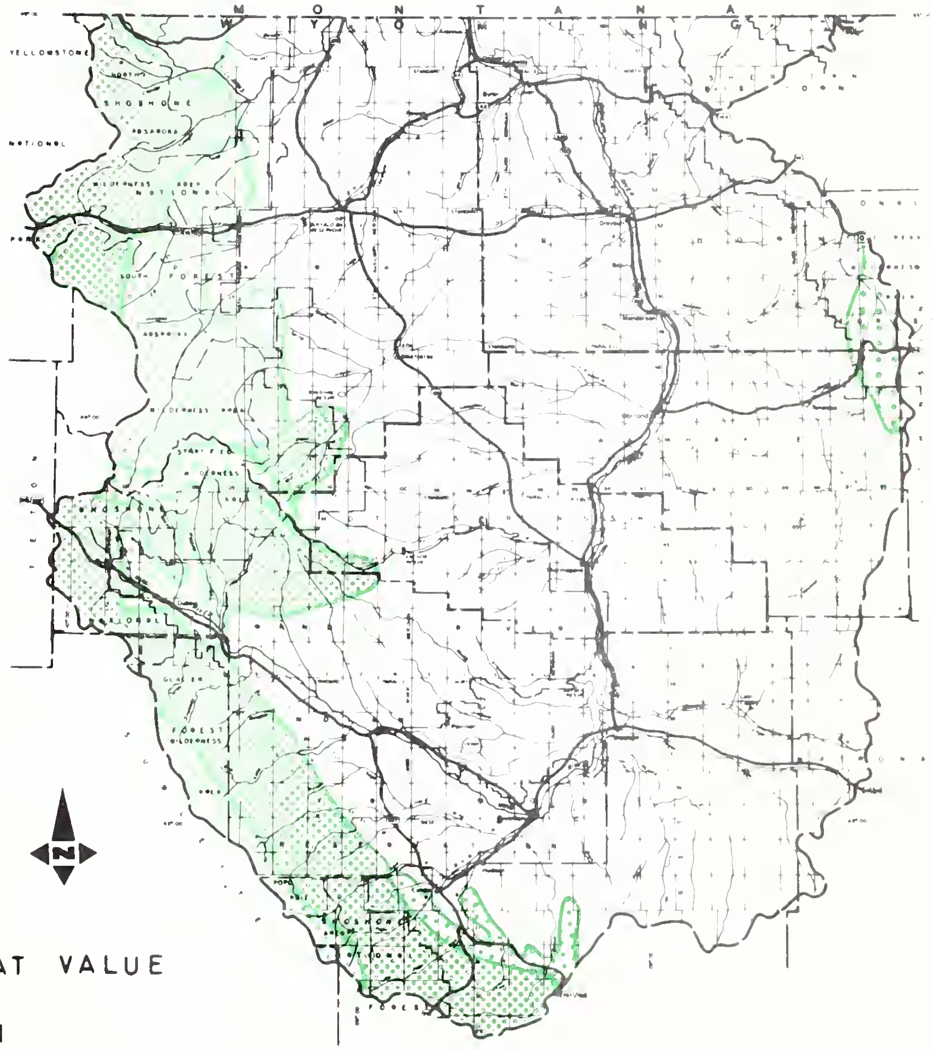
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin



MOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

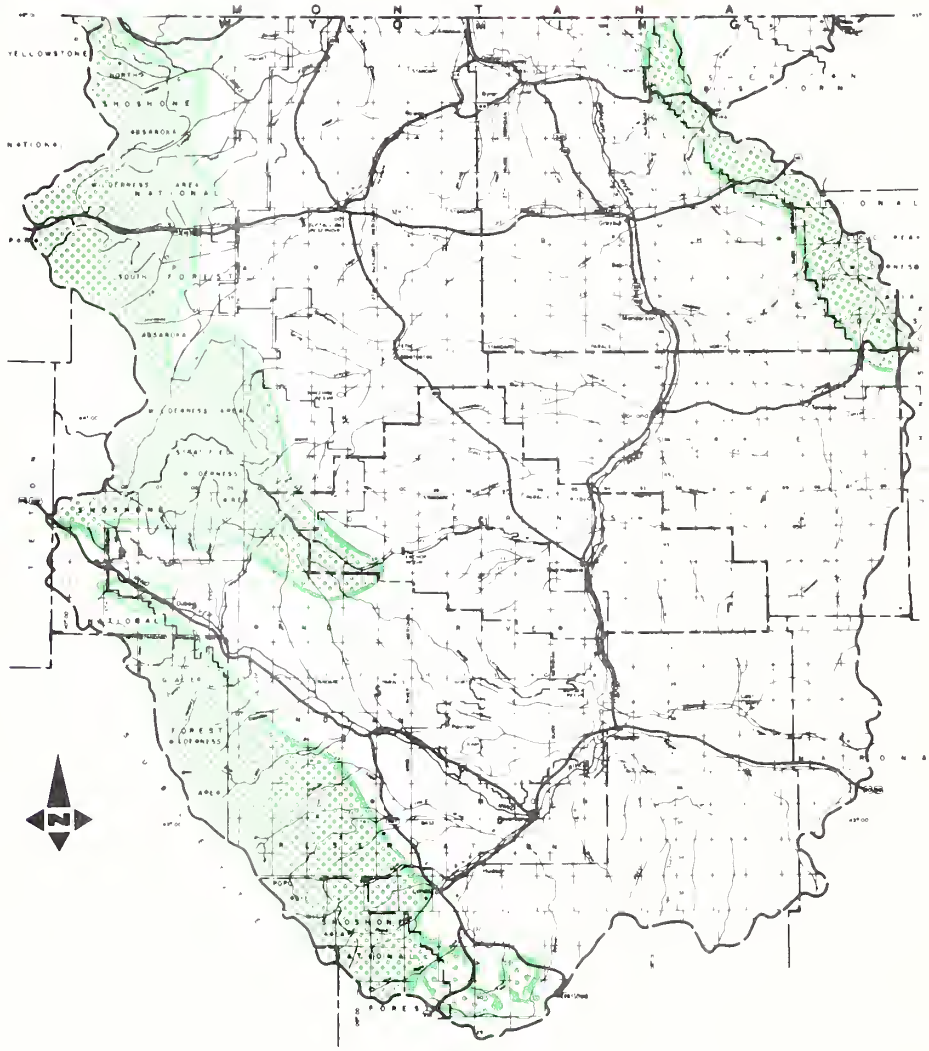
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study



BIGHORN SHEEP
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

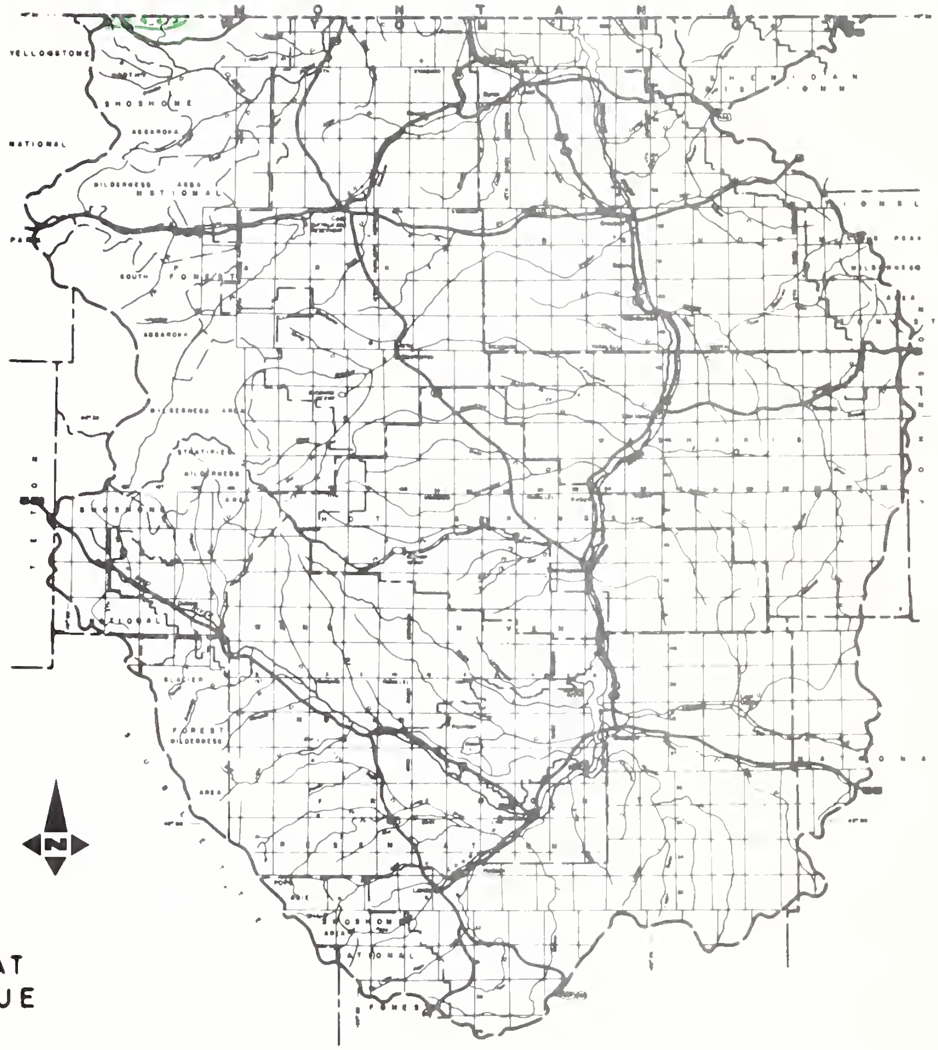
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin



MOUNTAIN GOAT
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

... from Missouri River Basin

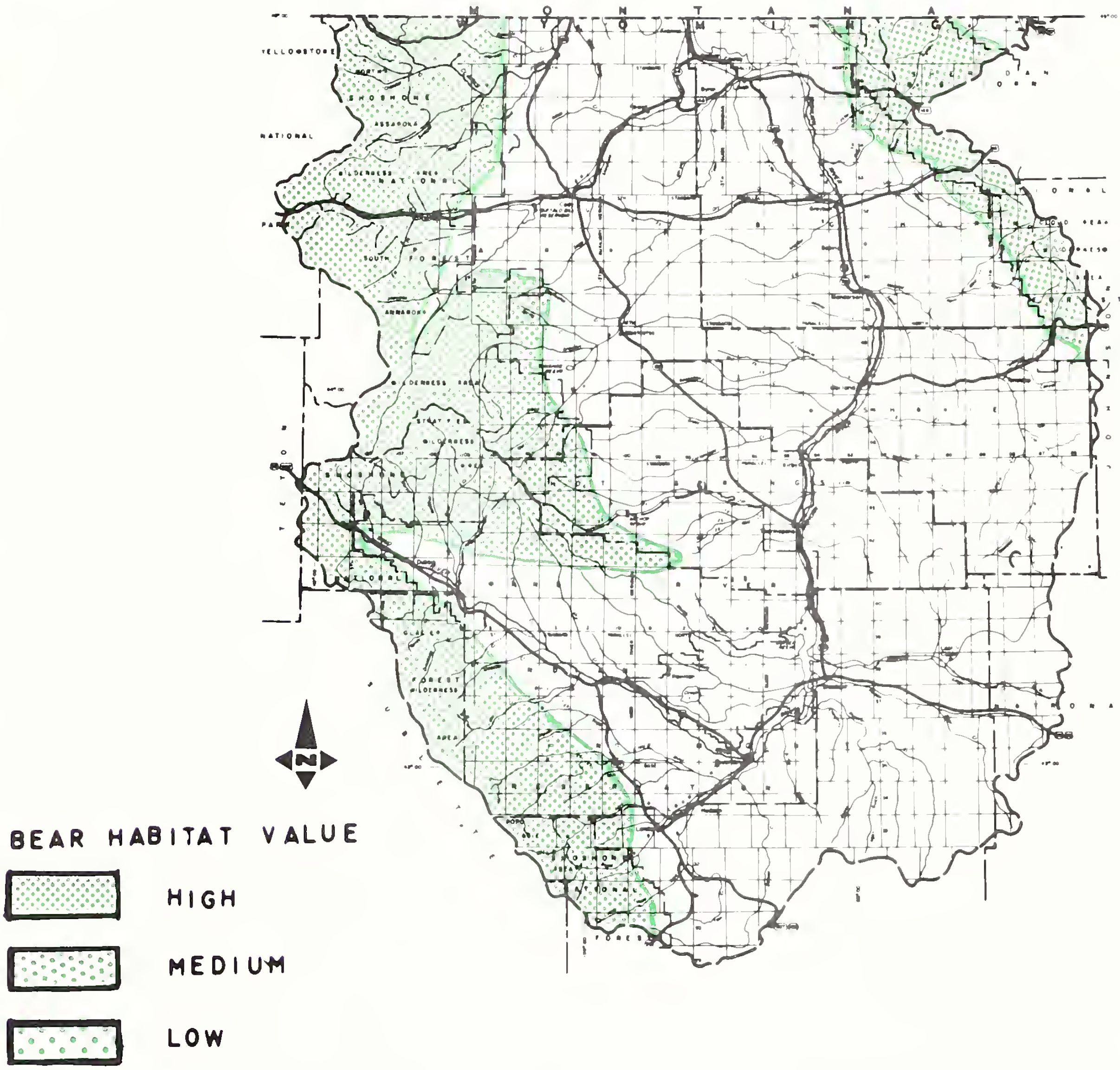


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

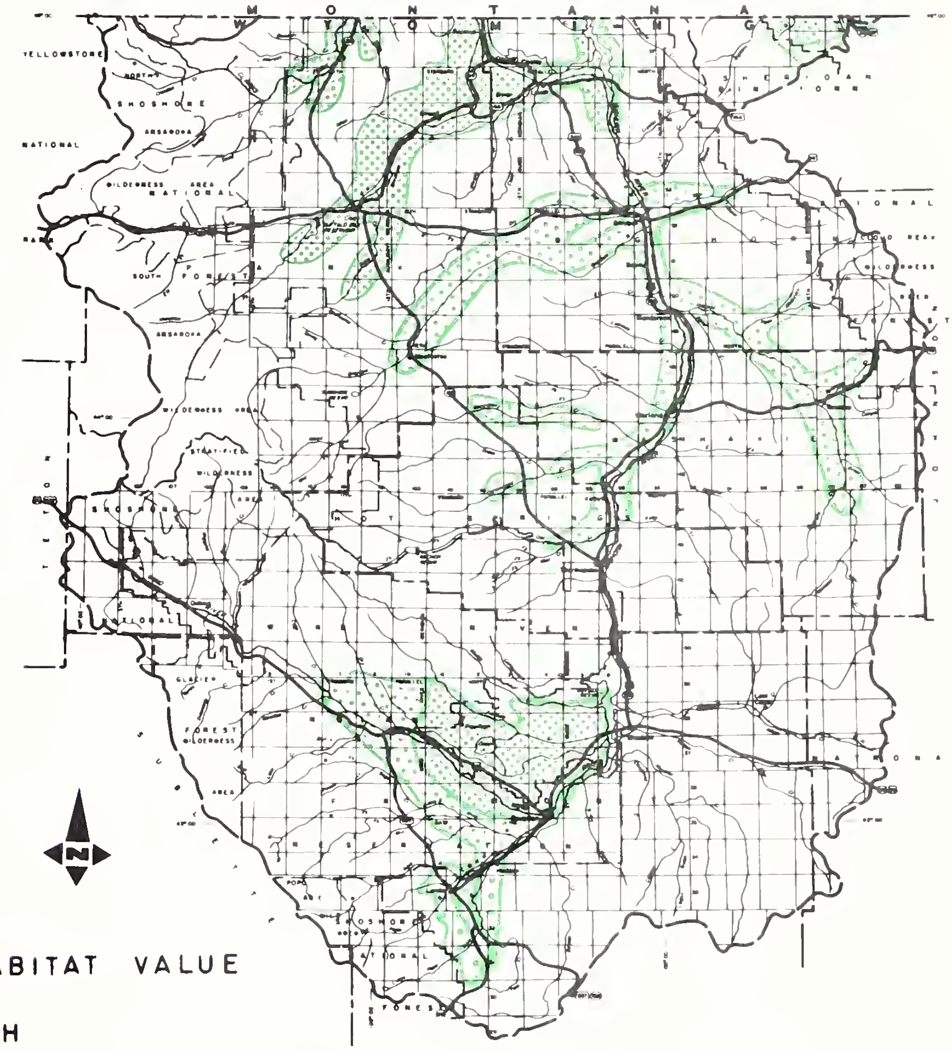
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study



PHEASANT HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

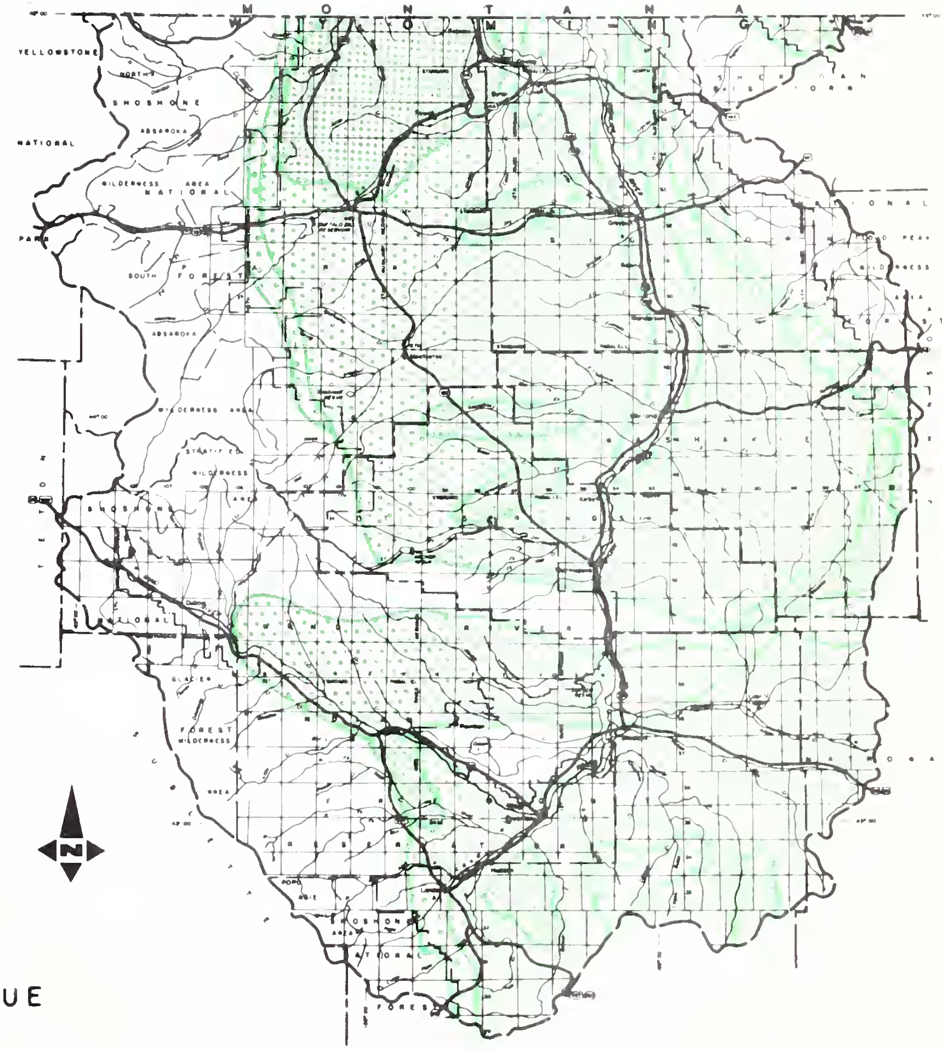
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



SAGE GROUSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

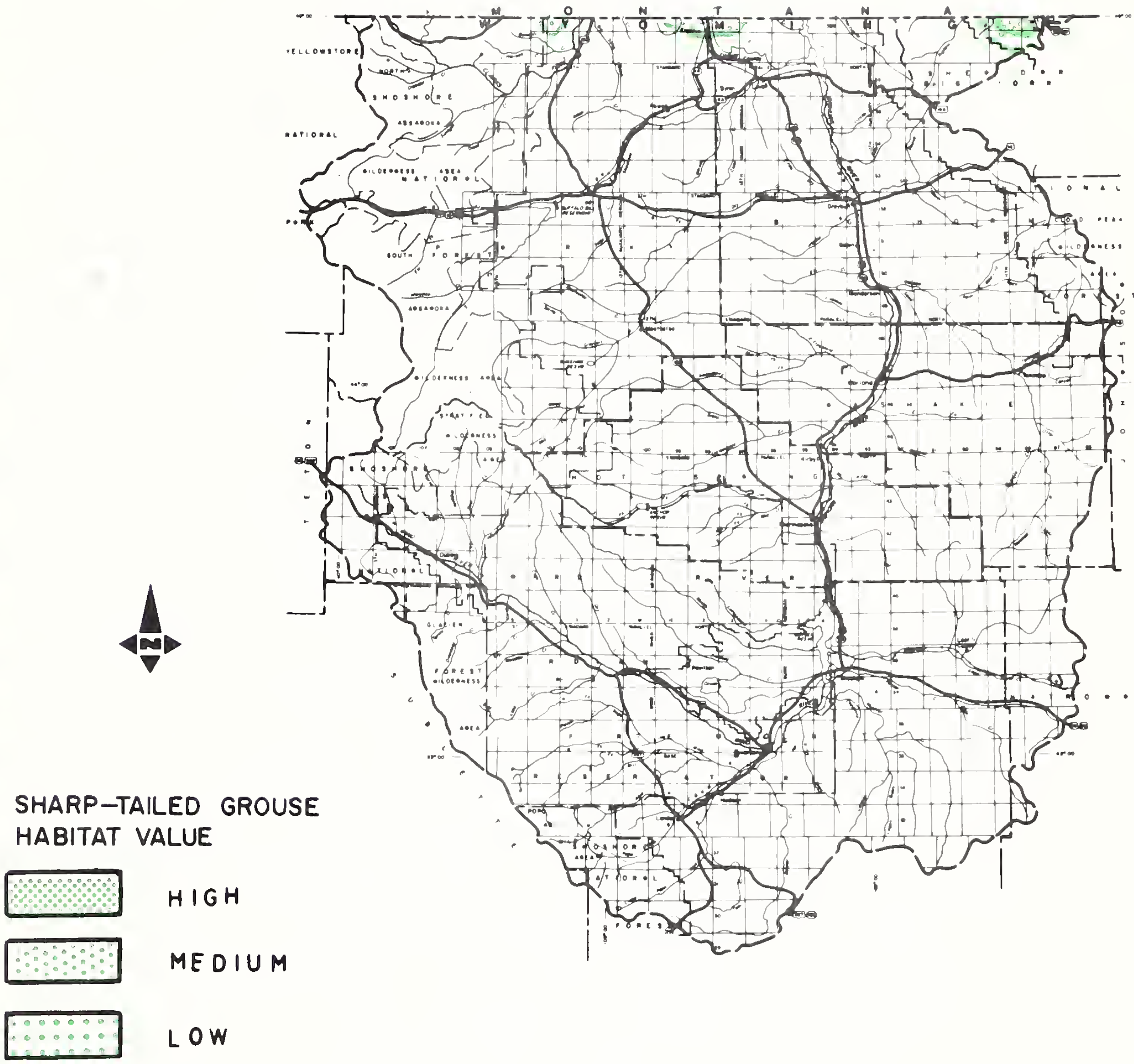


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975

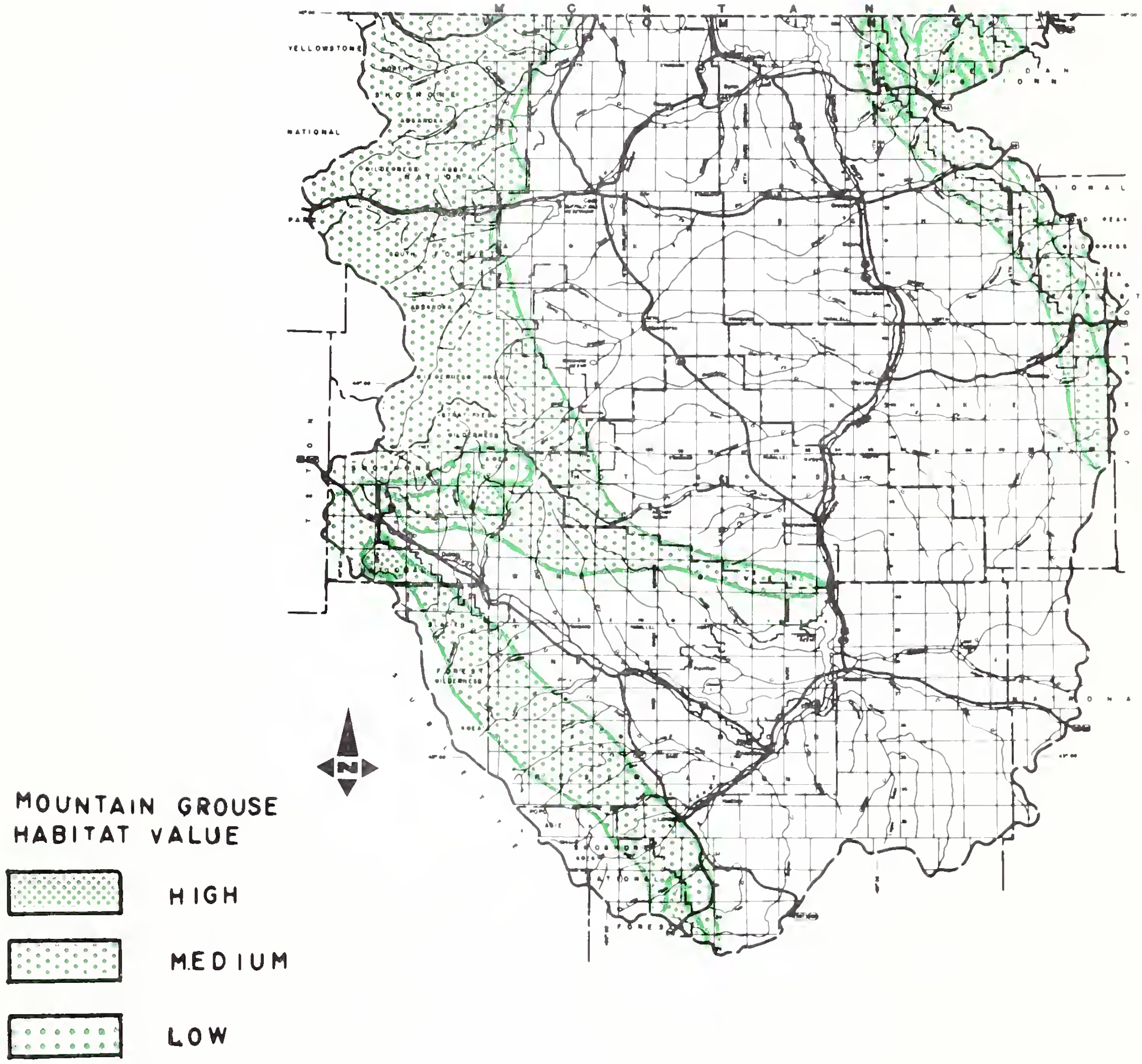


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

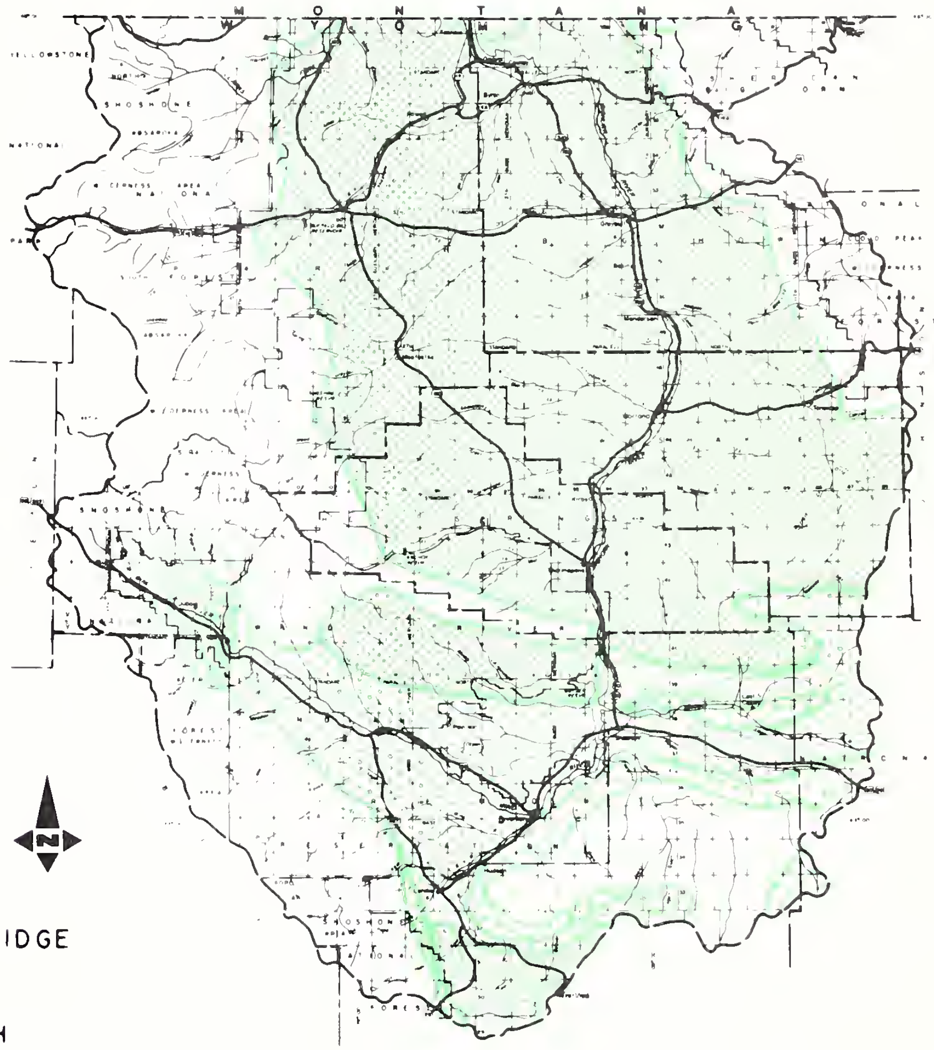
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study



CHUKAR PARTRIDGE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin

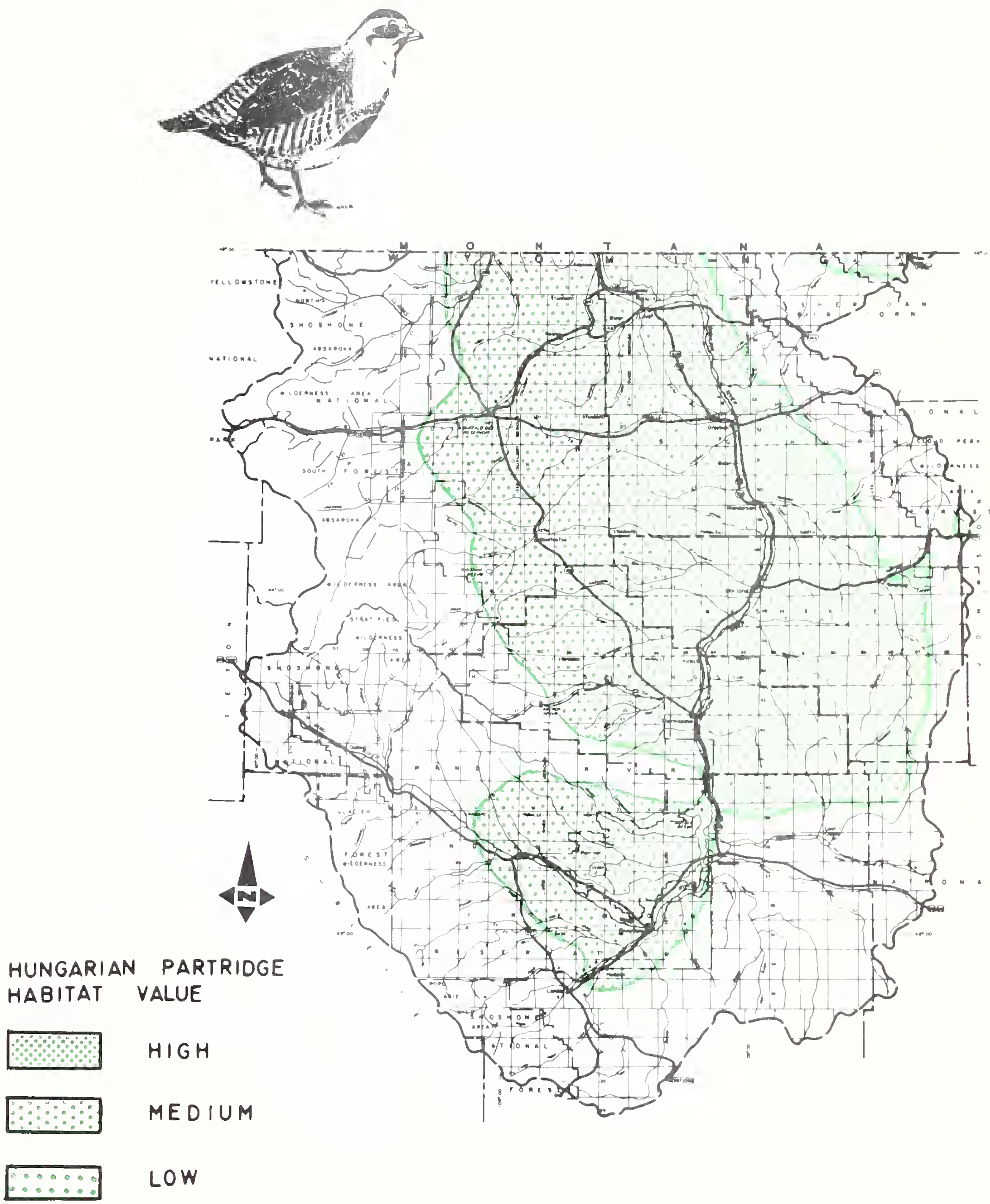


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975

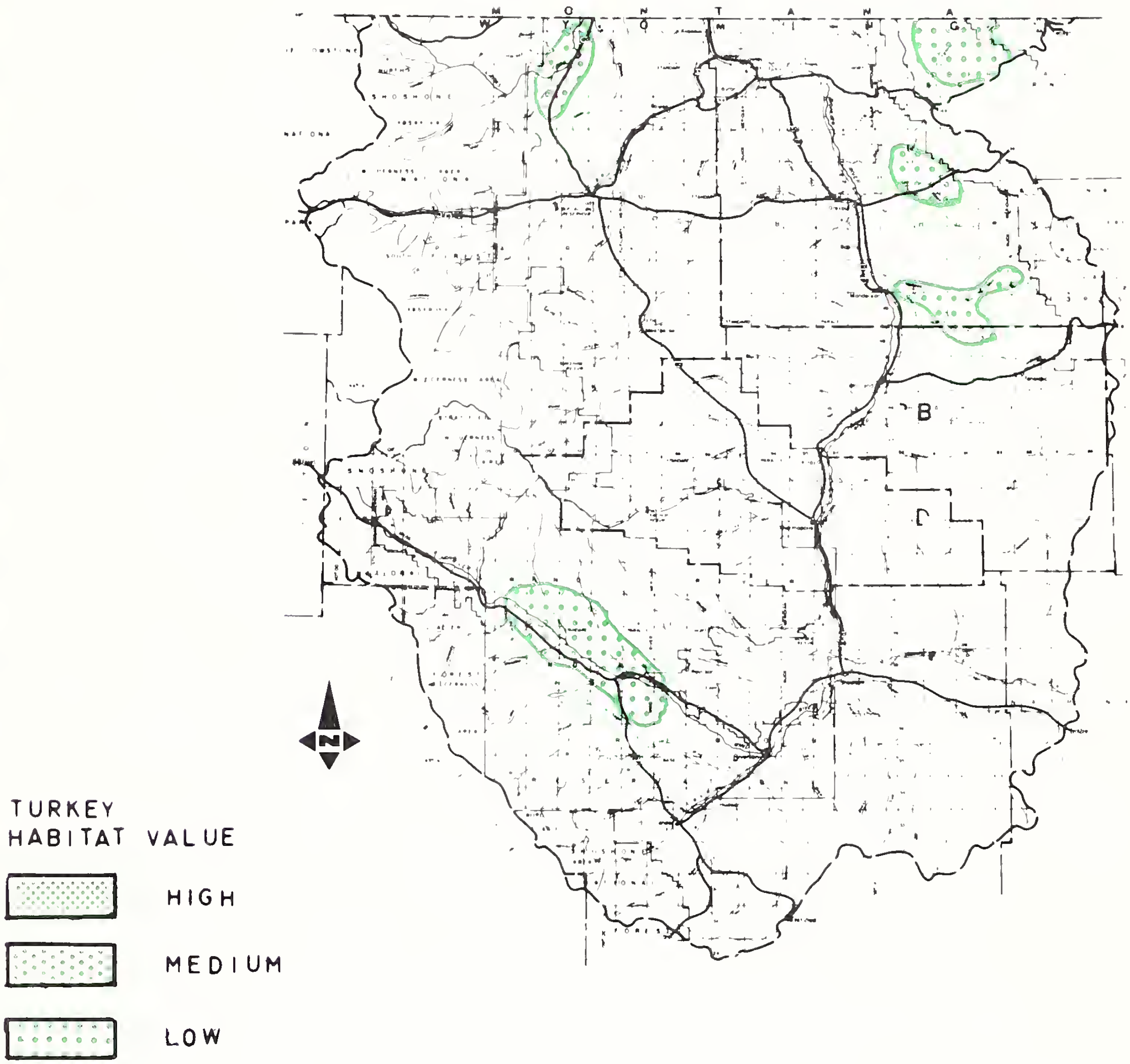


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

Table II-12--Area of big game ranges, 1969 1/

Species	Area inhabited 2/
	----1,000 acres---
Deer	8,764 3/
Elk	4,389
Moose	1,811
Bear	4,191
Antelope	8,742
Sheep	2,290
Mountain goat	100

1/ Includes portions of the Lander, Split Rock, and Ferris management areas.

2/ Data submitted for lands under the wildlife management jurisdiction of the Game and Fish Department (Indian and National Park lands are excluded in this table).

3/ Figure II-12 shows the entire area as deer habitat, but there are undelineated alpine areas, badland areas, urban areas, etc., which are not suitable habitat for deer.

Table II-13--Basic big game herd populations and estimated 1969 harvest

Species	Population	Estimated 1969 harvest
	----------------numbers----------------	
Deer	57,900	15,991
Elk	18,000	4,623
Moose	700	70
Bear	900	103
Antelope	13,100	3,094
Sheep & mountain goat	1,800	57

hungarian partridge, and chukar partridge.

The pheasant habitat is confined to the irrigated croplands located along creek and river bottoms, generally below 5,000 feet in elevation. Unless a program of habitat improvement is developed, pheasant habitat will deteriorate as fields become larger, cleaner farming is practiced, closed irrigation systems replace open ditches and reduce surface tailwater, and winter grazing of fields increases. Chukar habitat consists of semi-arid

Table II-14--Areas of upland game range and estimated 1969 harvest

Species	Area	Estimated 1969 harvest
	-1,000 acres-	--------numbers----------
Sage grouse	7,425	13,095
Chukar partridge	4,813	14,052
Hungarian partridge	4,375	3,762
Blue & Ruffed (mountain) grouse	3,706	410
Sharp-tailed grouse	N/A	N/A
Pheasant	803	25,767
Bobwhite quail	5	1/
Turkey	N/A	N/A
Cottontail rabbit	8,100	41,147

1/ No information available.

grazing lands and adjacent farm lands below 7,000 feet in elevation. Much of the area below 7,000 feet is also habitat for hungarian partridge. The best habitat is along creek and river bottoms in the farming areas. The balance of the partridge habitat is marginal. Blue and ruffed grouse live in mountainous, timbered areas. Blue grouse are found throughout the mountains. Ruffed grouse are limited to drainages along the face of the mountains.

Sagebrush areas below 7,000 feet are fair to good sage grouse habitat. The bobwhite habitat is restricted to a small portion of Big Horn County near the Yellowtail Wildlife Management Unit, and this is the only huntable population of bobwhites in Wyoming. Cottontail rabbits are found in all areas of the basin except in the mountains. Higher densities are found along the floodplains and benchlands of the major streams.

There are some turkey in the basin, but the marginal habitat cannot support a huntable population.

Waterfowl and wetland wildlife habitat

A complex of wetlands occurs in the basin and ranges from the margins of high mountain lakes to the margins of lower elevation lakes, reservoirs, streams, irrigation canals, drains, stock ponds, marshes, and irrigated lands.

Irrigated lands where grain crops are produced near open water areas are particularly important to waterfowl. Figure II-14 includes two maps showing major habitat areas and quality of habitat for ducks and geese. The maps in this figure were also taken from the Missouri River Basin Comprehensive Framework Study.

Bighorn sheep are native to the Bighorn Basin.

U.S. FOREST SERVICE PHOTO

Big game are plentiful in the basin.

There is a wide variety of game birds in the basin.

Outfitting and packing are important activities.
USDA - FOREST SERVICE PHOTO

Fishing in a mountain lake can be a unique recreation experience. USDA - FOREST SERVICE PHOTO

The Buffalo Bill Museum at Cody is one of the most popular tourist stops in the basin.

PLATE 8

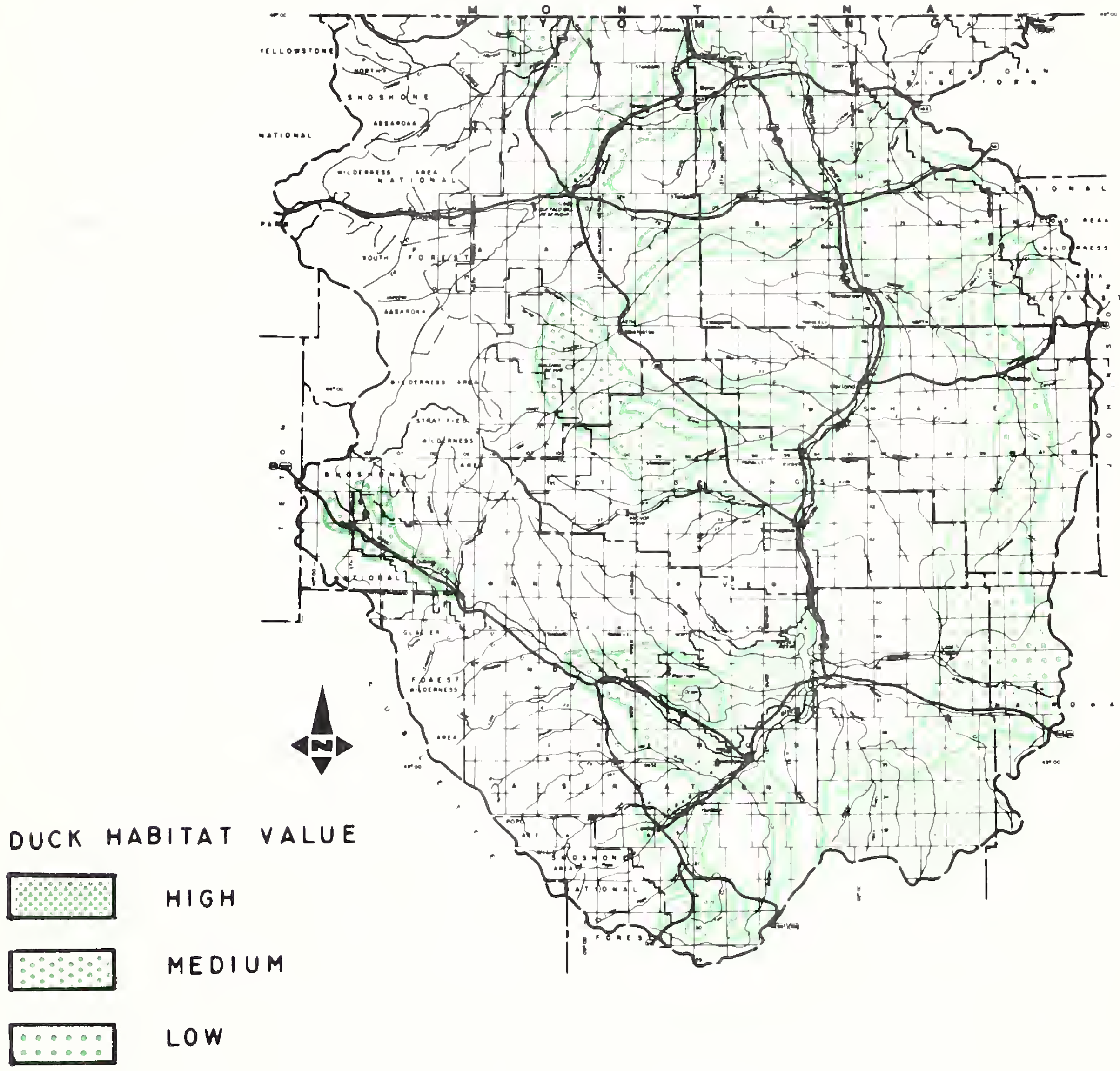


FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

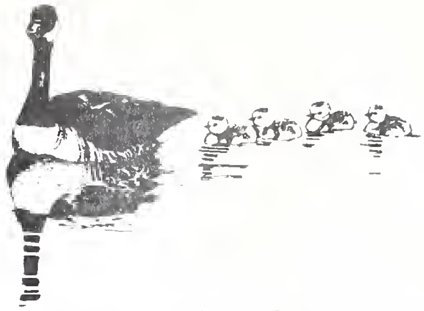
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



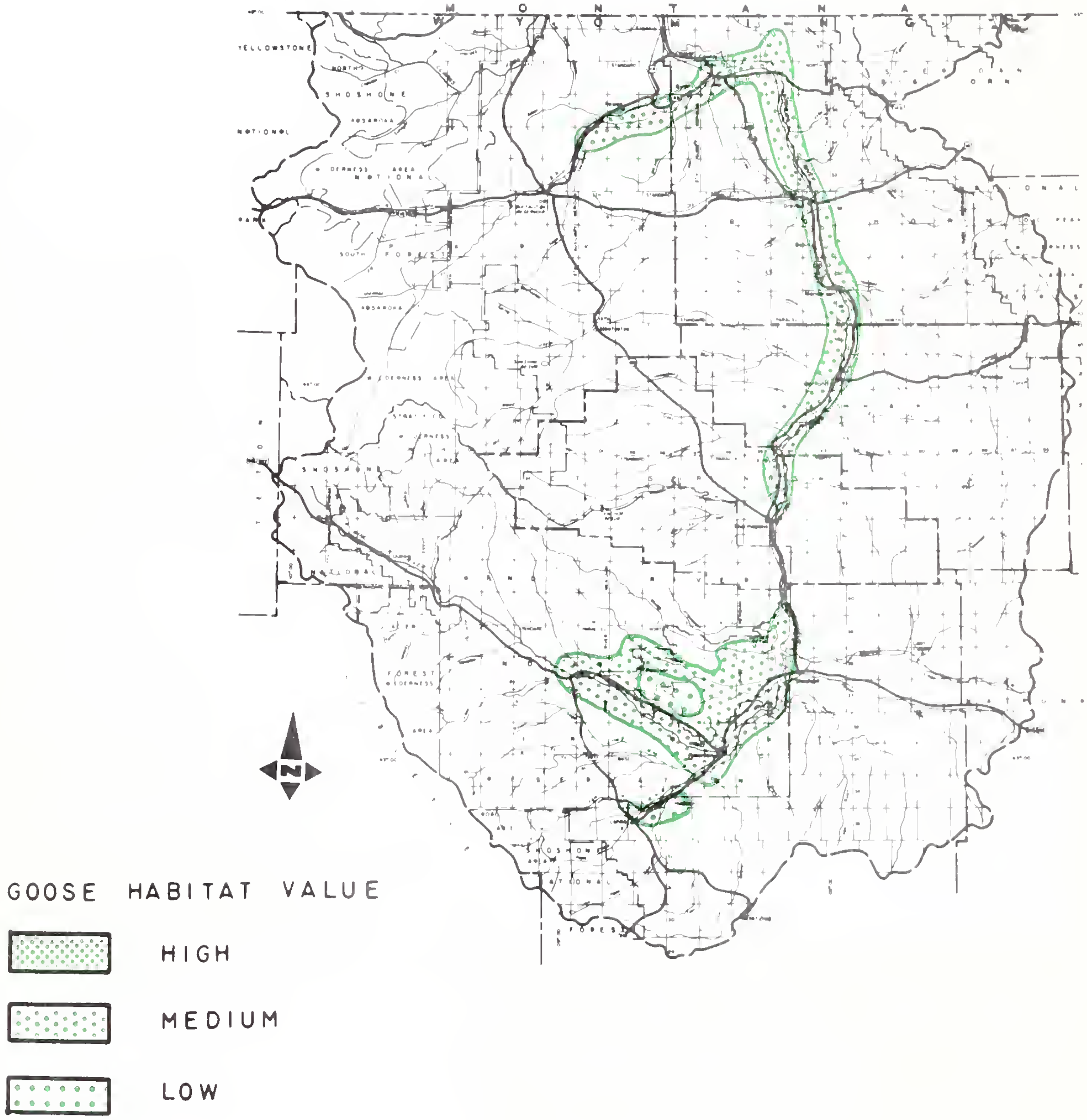


FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,10[illegible]

Adopted from Missouri River Basin
Comprehensive Framework Study

The Wyoming Game and Fish Commission owns 2,280 acres and administers 10,520 acres of federal lands near Riverton as a major wildlife management facility. Of the total area, about 6,300 acres are surface waters of Ocean Lake. The Yellowtail Wildlife Management Area of about 14,410 acres is managed by the Wyoming Game and Fish Commission under cooperative agreements with U. S. Department of Interior agencies. Marshes and water control facilities will be developed on about 1,000 acres in this area. Each year, more ranchers are constructing stock ponds; and many are used by waterfowl for brooding. There are presently about 1,700 stock ponds in the basin. Beaver ponds and mountain wetland areas are also attractive to waterfowl. Waterfowl game species found in the basin are canada geese, snow geese, mallards, and other ducks.

Non-game bird habitat

Numerous species of resident and migratory birds, other than those classed as game birds by Wyoming statutes, exist throughout the entire basin. Table II-15 is a list of both game and nongame species which may be seen in the basin.

In addition to the game bird classification, Wyoming statutes include three bird classes which are:

a. Predacious birds. This includes english sparrows, magpie, starling, and crow.

b. Protected birds. This includes pellican, swan, bittern, gull, falcon, hawk, owl, eagle, heron, kingfisher, and each insectivorous and song bird not herein otherwise specifically named or classified.

c. Migratory birds. This includes all migratory game birds defined and protected under federal law.

Management for all of the above species, with the exception of some migratory birds, is based on a general philosophy of offering legal protection to those species determined to need protection, participation in control programs involving certain predacious species, and giving consideration to nongame species in management programs for game species. The latter recommendation is based on the knowledge that improvement of habitat for game species will benefit most other species as well. Future programs will require more specific attention to nongame birds because of increased human population pressures on the natural habitat of all wildlife species.

Migratory birds are managed by cooperative arrangements between federal and state wildlife agencies, whereby some species are maintained in numbers sufficient to provide a harvestable surplus and others are totally protected.

Fisheries

The streams in the basin have been classified by the Wyoming Game and Fish Commission into five classifications based upon aesthetics, availability,

Table II-15--Birds seen in the Wind-Bighorn-Clarks Fork River Basin 1/

Name of Species	Code	Name of Species	Code	Name of Species	Code
Common Loon	(3m s)	Turkey Vulture	(2s)	Greater Yellowlegs	(3m)
Horned Grebe	(2m)	Goshawk	(3r)	Lesser Yellowlegs	(2m)
Eared Grebe	(2s)	Sharp-shinned Hawk	(3r)	Knot	(5m)
Western Grebe	(2s)	Cooper's Hawk	(3r)	Pectoral Sandpiper	(3m)
Pied-billed Grebe	(2s)	Red-tailed Hawk	(2r)	White-rumped Sandpiper	(4m)
White Pelican	(2m s)	Broad-winged Hawk	(5m)	Baird's Sandpiper	(2m)
Double-crested Cormorant	(2m s)	Swainson's Hawk	(2s)	Least Sandpiper	(2m)
Great Blue Heron	(2s)	Rough-legged Hawk	(2wv)	Dunlin	(4m)
Green Heron	(4m)	Ferruginous Hawk	(2s)	Long-billed Dowitcher	(2m)
Snowy Egret	(3m s)	Golden Eagle	(2r)	Stilt Sandpiper	(3m)
Black-crowned Night Heron	(2m s)	Bald Eagle	(2wv s)	Semipalmated Sandpiper	(3m)
American Bittern	(3a)	Marsh Hawk	(2r)	Western Sandpiper	(3m)
White-faced Ibis	(3m)	Osprey	(3m s)	Marbled Godwit	(3m)
Whistling Swan	(4m)	Prairie Falcon	(3r)	Hudsonian Godwit	(5m)
Canada Goose	(2r)	Peregrine Falcon	(4r)	Sanderling	(3m)
Snow Goose	(4m)	Pigeon Hawk	(4r)	Avocet	(2s)
Mallard	(2r)	Sparrow Hawk	(2s)	Black-necked Stilt	(4s)
Gadwall	(2s)	Sage Grouse	(2r)	Wilson's Phalarope	(1s)
Pintail	(2s)	Ring-necked Pheasant	(2r)	Northern Phalarope	(2m)
Green-winged Teal	(2s)	Chukar	(2r)	Herring Gull	(4m)
Blue-winged Teal	(2s)	Gray Partridge	(r)	California Gull	(2r)
Cinnamon Teal	(2s)	Sandhill Crane	(2s)	Ring-billed Gull	(2m)
American Widgeon	(2s)	Virginia Rail	(3s)	Franklin's Gull	(2m)
Shoveler	(2s)	Sora	(2s)	Bonaparte's Gull	(3m)
Redhead	(2s)	American Coot	(1s)	Sabine's Gull	(4m)
Ring-necked Duck	(3m)	Semipalmated Plover	(3m)	Forster's Tern	(2m)
Canvasback	(2m s)	Piping Plover	(4m)	Common Tern	(4m)
Greater Scaup Duck	(4m)	Snowy Plover	(5m)	Caspian Tern	(3s)
Lesser Scaup Duck	(2s)	Killdeer	(1s)	Black Tern	(2s)
Common Goldeneye	(2wv)	Mountain Plover	(3s)	Mourning Dove	(1s)
Barrow's Goldeneye	(2m s)	American Golden Plover	(5m)	Black-billed Cuckoo	(3s)
Bufflehead	(2m s)	Black-bellied Plover	(3m)	Screech Owl	(4s)
Oldsquaw	(5m)	Ruddy Turnstone	(4m)	Horned Owl	(2r)
Harlequin Duck	(3s)	Common Snipe	(2r)	Snowy Owl	(4wv)
White-winged Scoter	(4m)	Long-billed Curlew	(2s)	Burrowing Owl	(3s)
Surf Scoter	(4m)	Whimbrel	(3m)	Long-eared Owl	(3r)
Ruddy Duck	(2s)	Upland Plover	(2s)	Short-eared Owl	(2r)
Hooded Merganser	(3m)	Spotted Sandpiper	(2s)	Saw-whet Owl	(4m)
Common Merganser	(2r)	Solitary Sandpiper	(2m)	Poor-will	(2s)
Red-breasted Merganser	(3m)	Willet	(2s)	Common Nighthawk	(2s)
White-throated Swift	(2s)	House Wren	(2s)	Red-winged Blackbird	(1s)
Broad-tailed Hummingbird	(2s)	Winter Wren	(4m)	Bullock's Oriole	(2s)
Rufous Hummingbird	(3m)	Long-billed Marsh Wren	(2s)	Rusty Blackbird	(4m)
Calliope Hummingbird	(2s)	Rock Wren	(1s)	Brewer's Blackbird	(2r)
Belted Kingfisher	(2r)	Mockingbird	(3r)	Common Grackle	(2s)
Yellow-shafted Flicker	(3r)	Catbird	(2s)	Brown-headed Cowbird	(2s)
Red-shafted Flicker	(2r)	Brown Thrasher	(2s)	Western Tanager	(2s)
Red-headed Woodpecker	(3s)	Sage Thrasher	(2s)	Black-headed Grosbeak	(2s)
Lewis' Woodpecker	(2s)	Robin	(1r)	Blue Grosbeak	(4s)
Yellow-bellied Sapsucker	(2s)	Hermit Thrush	(3s Mts)	Indigo Bunting	(4s)
Hairy Woodpecker	(2r)	Swainson's Thrush	(2s Mts)	Lazuli Bunting	(2s)
Downy Woodpecker	(2r)	Veery	(2s)	Evening Grosbeak	(2wv)
Eastern Kingbird	(2s)	Mountain Bluebird	(2s)	Caccin's Finch	(2r)
Western Kingbird	(2s)	Townsend's Solitaire	(2r Mts)	House Finch	(2r)
Say's Phoebe	(2s)	Golden-crowned Kinglet	(2s Mts)	Pine Grosbeak	(3r Mts)
		Ruby-crowned Kinglet	(2s Mts)		
Traill's Flycatcher	(2s Mts)	Water Pipit	(2s A)	Gray-crowned Rosy Finch	(2wv 2s)
Least Flycatcher	(2s)	Bohemian Waxwing	(2wv)	Black Rosy Finch	(2s Mts)
Dusky Flycatcher	(2s)	Cedar Waxwing	(2s)	Common Redpoll	(2wv)
Western Flycatcher	(2s)	Northern Shrike	(2wv)	Pine Siskin	(2s)
Western Wood Pewee	(1s)	Loggerhead Shrike	(2s)	American Goldfinch	(2s)
Olive-sided Flycatcher	(3s Mts)	Starling	(2r)	Red Crossbill	(2r Mts)
Horned Lark	(1r)	Solitary Vireo	(3s)	White-winged Crossbill	(4m)
Violet-green Swallow	(2s)	Red-eyed Vireo	(2s)	Green-tailed Towhee	(2s Mts)
Tree Swallow	(2s)	Warbling Vireo	(1s)	Rufous-sided Towhee	(2s)
Bank Swallow	(3s)	Tennessee Warbler	(4m)	Lark Bunting	(1s)
Rough-winged Swallow	(2s)	Orange-crowned Warbler	(2s)	Savannah Sparrow	(2s)
				Grasshopper Sparrow	(2s)
Barn Swallow	(3s)	Nashville Warbler	(4m)	Vesper Sparrow	(1s)
Cliff Swallow	(1s)	Yellow Warbler	(1s)	Lark Sparrow	(2s)
Purple Martin	(4s)	Myrtle Warbler	(2m)	Slate-colored Junco	(3wv)
Gray Jay	(2r Mts)	Audubon's Warbler	(2s)	Oregon Junco	(2r)
Steller's Jay	(2r Mts)	Black-throated Gray Warbler	(2s)	Gray-headed Junco	(2s Mts)
Black-billed Magpie	(1r)	Townsend's Warbler	(3m)	Tree Sparrow	(2wv)
Common Raven	(2r Mts)	Blackpoll Warbler	(4m)	Chipping Sparrow	(2s Mts)
Common Crow	(2r)	Northern Waterthrush	(3m)	Brewer's Sparrow	(2s)
Pinon Jay	(2r)	MacGillivray's Warbler	(2s Mts)	Harris' Sparrow	(3wv)
Clark's Nutcracker	(2r Mts)	Yellowthroat	(2s)	White-crowned Sparrow	(2s Mts)
Black-capped Chickadee	(2r)	Yellow-breasted Chat	(2s)	White-throated Sparrow	(3m)
Mountain Chickadee	(2r)	Wilson's Warbler	(2s Mts)	Fox Sparrow	(2s 3wv)
White-breasted Nuthatch	(2r)	American Redstart	(3s)	Lincoln's Sparrow	(2s Mts)
Red-breasted Nuthatch	(2r)	House Sparrow	(1r)	Song Sparrow	(2r)
Pygmy Nuthatch	(3ri)	Bobolink	(3s)	McCown's Longspur	(2s)
Brown Creeper	(2r)	Western Meadowlark	(1s)	Lapland Longspur	(3m)
Water Ouzel	(2s Mts)	Yellow-headed Blackbird	(2s)	Snow Bunting	(3wv)

KEY TO CODE

1 - abundant
2 - common
3 - uncommon
4 - rare
5 - casual

m - migrant
s - summer resident
r - resident
wv - winter visitant
f - formerly
i - irregular

Mts - mountains
A - alpine zone

1/ Prepared by Dr. Oliver Scott in affiliation with the Murie Audubon Society, Casper, Wyoming.

and productivity. The total stream miles, as well as minimum miles, were determined for each stream which was actually producing or providing fishery and are listed in table II-16 and shown in figure II-15.

There are more than 4,200 miles of streams that have been classified. The stream habitat varies from small streams with beaver ponds to large flowing streams. As shown on the map, class 1 represents fisheries of national importance, class 2 of statewide importance, class 3 of regional importance, class 4 of local importance, and class 5 are often incapable of sustaining a fishery. The Wind River below Boysen Dam is the only stream with a class 1 designation. Most of the stream miles are classed as 2, 3, and 4 waters. The class 5 streams have little fishery potential or fishing pressure.

Class 1 streams are considered top quality trout streams. As one progresses from class 1 to class 5 streams, the quality of the streams diminishes. Over 70 percent of the stream mileage is on public lands, and the rest on private lands.

Lentic waters producing or providing a fishery have a surface area of about 61,341 acres. These lakes, reservoirs, and ponds were not classified like the streams but were categorized by seven types and listed by county in table II-17.

Streams presently provide about 26,300 fisherman days of fishing per year while lakes, ponds, and reservoirs provide about 103,500 days. Existing streams could sustain about 80,000 days per year and existing ponds, lakes, and reservoirs about 406,000.

Fur animal habitat

Beaver, mink, muskrat, otter, martin, red fox, skunk, weasel, raccoon, jackrabbit, badger, coyote, bobcat, lynx, mountain lion, and limited numbers of fisher and wolverine are fur animals that may be found in portions of the basin.

Table II-16--Summary of stream miles of fishery

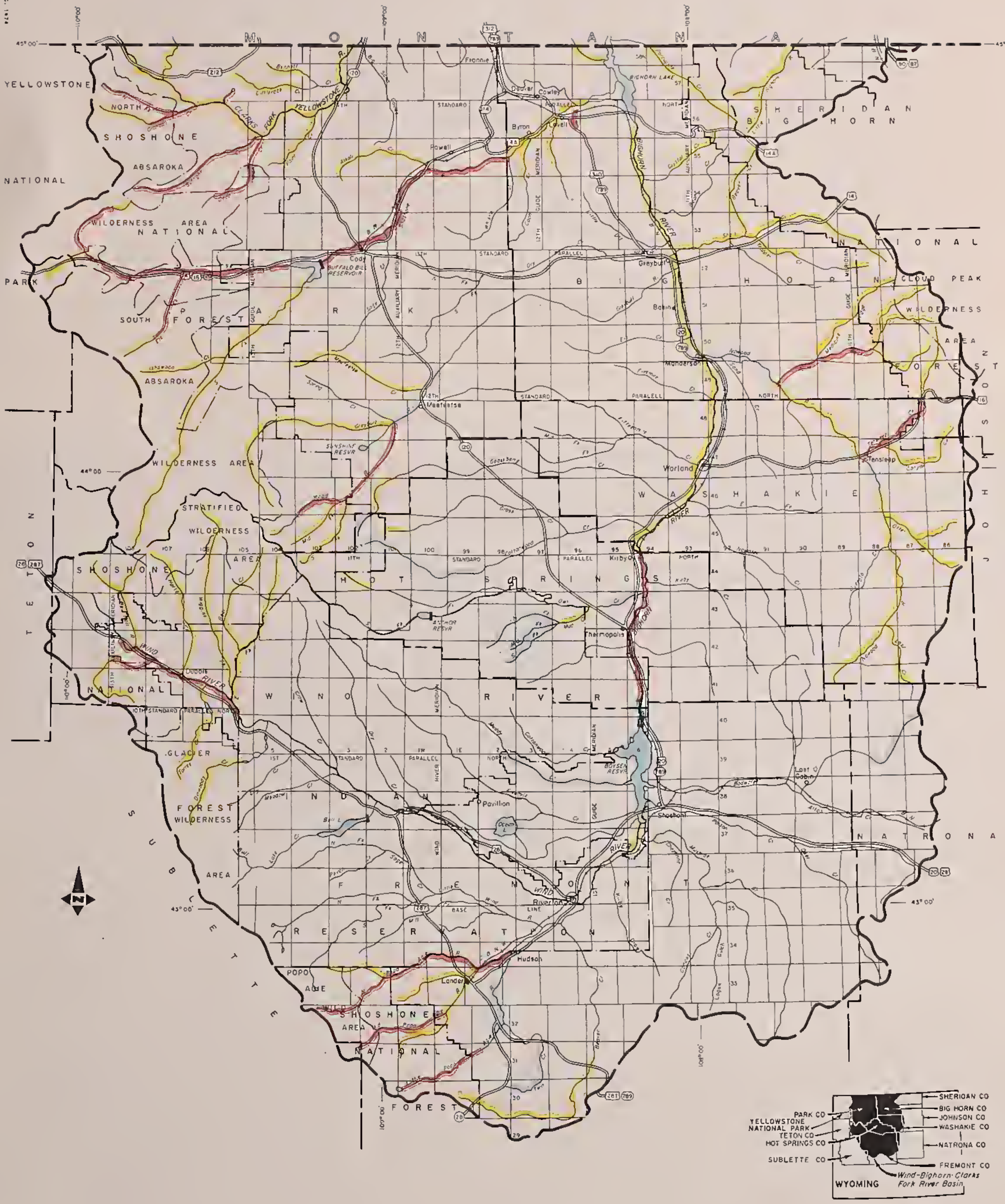
County 1/	Class 1	Class 2	Class 3	Class 4	Class 5	Total
	minimum miles					
Fremont	3.0	131.8	893.2	699.5	46.5	1,774.0
Big Horn	0.0	19.5	442.3	102.0	13.9	577.7
Hot Springs	0.0	30.7	37.5	170.3	5.3	243.8
Park	0.0	251.4	883.5	257.3	12.2	1,404.4
Washakie	0.0	15.2	178.2	57.7	3.3	254.4
Total	3.0	448.6	2,434.7	1,286.8	81.2	4,254.3

1/ Gross areas for counties may include some areas outside the basin.

Table II-17--Lakes, reservoirs, and ponds with fisheries

County[1/]	Natural lakes		Reservoirs		Farm ponds by type of fish			Total
	Alpine	Lowland	Alpine	Lowland	Cold water	Warm water	Mixed	
	---number---							
Fremont	518	17	9	26	56	5	0	631
Big Horn	67	2	8	13	12	18	0	120
Hot Springs	1	0	0	5	10	7	2	25
Park	155	11	7	20	30	6	1	230
Washakie	0	0	1	11	18	6	2	38
Total	741	30	25	75	126	42	5	1,044

1/ Gross areas for counties may include some areas outside the basin.



LOCATION MAP

STREAM FISHERY CLASSIFICATION

- Premium trout waters – fisheries of national importance
- Very good trout waters – fisheries of statewide importance
- Important trout waters – fisheries of regional importance
- Low production waters – fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure

FIGURE II-15

STREAM FISHERY CLASSIFICATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

Rare and endangered species

Mammal, bird, and fish species which may be found in the basin that are threatened or which are limited in numbers but for which status is still undetermined are listed below in common names:

Status	Class	Species
Rare	Mammal	Spotted bat Grizzly bear
	Bird	Prairie falcon Greater sandhill crane
	Fish	Grayling Silvery minnow
Threatened	Mammal	Black-footed ferret
	Bird	American peregrine falcon
	Fish	Shovelnose sturgeon Goldeye Sturgeon chub
Status undetermined	Mammal	Pine martin Fisher Wolverine Canada lynx
	Bird	Ferruginous hawk American osprey

Compiled from:

Rare and Endangered Fish and Wildlife of the United States. Resource publication 34, Bureau of Sport Fisheries and Wildlife, July 1966.

Wyoming Fishes. Baxter, George T. and James R. Simon, 1970.

Threatened Fishes of the United States. Miller, Robert Rush, Transactions of the American Fisheries Society, Vol. 101, No. 2, April 1972.

Threatened Wildlife of the United States, Resource Publication, Bureau of Sport Fisheries and Wildlife, March 1973.

Recommendations of Wyoming Game and Fish Department.

RECREATIONAL FEATURES

Outstanding natural and scenic resources offer great opportunities for outdoor recreation in the basin. The mountainous areas which surround the basin are the principal base of recreational activity because of their pleasant summer climate, scenery, lakes and streams, and wildlife. Scattered glacial lakes and mountain streams provide spectacular scenery and cold water fishing. Federal and state highways, county, forest, and private roads provide access to some of the scenic areas not included in wilderness or primitive areas. Within the lower areas of the basin are scenic desert formations, larger rivers, lakes, and reservoirs such as Boysen, Bighorn, and Buffalo Bill. Private irrigated lands add greenery to the desert landscapes. Other private lands serve as a base for recreational activities on public lands as they are used for "dude" ranches, lodges, summer cottages, campgrounds, and service areas.

Some of the more important of outdoor recreation uses are camping, hunting, fishing, hiking, and packing, sight-seeing, rock hounding, snow-mobiling, skiing, visits to historic sites, and sites for summer cottages.

About 6,000 miles of streams in the basin provide opportunities for fishing, tubing, boating, canoeing, and other associated sports. There are about 70,000 surface acres of lakes and reservoirs which are used for fishing as well as other water sports.

QUALITY OF THE NATURAL ENVIRONMENT

General

The low population density of about three persons per square mile has tended to preserve much of the quality of the environment in a semi-native state. However, the environment has been altered, to varying degrees, by activities of man. Past grazing by livestock and wildlife has been excessive for the resource in some areas and caused an increase in the amount of big sagebrush. It is generally considered that pure stands of big sagebrush do not provide quality watersheds. About a half million acres of irrigated cropland have been developed along mountain streams and on desert benches. Inefficient irrigation practices which result in large amounts of waste water have caused erosion of small streams and waterways and deposited sediment into the larger rivers and man-made lakes.

These irrigation diversions also affect fish habitat by reducing natural streamflows. Conversely, irrigated lands have encouraged increased numbers of some species of wildlife and allowed introduction of some exotic species such as the pheasant.

Recreational demands by hunters, fishermen, and tourists have affected environmental quality in more remote regions. Mining and oil field development have affected landscapes and streams.

Forests are very important components of the natural environment.

Forested lands are quite stable, and, unless disturbed, have low rates of erosion and sediment production.

Some of the forested land has been harvested for wood products. Harvest is necessary to keep the forest in good condition to provide wildlife habitat, recreation, wood products, good winter snowpack development, and the release of good quality streamflows.

Water quality

In the planning of the use of water resources, consideration must be given to water quality. Every water use has definite water quality requirements. Whenever water quality deteriorates below the minimum requirement of any use, the use is lost or made more expensive by the need for water treatment. The aim of the State Water Quality Program is to maintain the quality of the state waters such that true multiple water uses can be maintained.

The quality of most of the waters of this river basin can be described as good. Excellent quality is found in the high mountains where most of the basin's water originates. Remoteness and lack of developed access has protected water quality in these mountainous forest watersheds. However, there is a gradual decline in quality as the water moves downstream.

This decrease in quality is largely the result of natural conditions. Runoff from lower elevation lands carries much higher concentrations of minerals, sediments, and other pollutants than runoff from the mountain watersheds.

While there are places on the streams, notably near towns and a few feedlots where biologic pollutants are discharged into streams, we have no record of significant adverse effects at present. Dissolved oxygen levels are apparently satisfactory at all locations where sampling is conducted on a regular basis. The major pollutants of water in the basin are suspended sediments and dissolved solids. Table II-18 is a list of the average annual concentration of dissolved solids at locations where these data are measured and published by the U. S. Geological Survey.

Concentrations of dissolved solids (TDS) and suspended sediments vary greatly during the year. For example, in water year 1966, TDS in the Little Wind River near Riverton varied from 290 mg/l on May 15 to 842 on August 20 and 874 on March 18. The suspended sediment in Fivemile Creek near Shoshoni in the same year varied from 180 mg/l on November 7 to 3,900 mg/l on April 16. Badwater Creek at Lysite varied from 68 mg/l on January 7 to 38,000 mg/l on June 23. Suspended sediment loads are not widely measured in the basin and are not listed here for that reason. The recommended maximum concentration of total dissolved solids in private or semi-public water supplies is 1,000 mg/l when no other water is available and for livestock up to 2,500 mg/l is acceptable.

Table II-18--Average annual concentration of total dissolved solids

Gaging location	Total dissolved solids
	-------- mg/l ---------
Wind River near Dubois	105
Wind River at Riverton	205
Little Wind River near Riverton	390
Fivemile Creek near Shoshoni	1,240
Wind River below Boysen	460
Bighorn River at Lucerne	520
Bighorn River at Neiber	555
Bighorn River at Worland	600
Nowood River at Manderson	470
Greybull River near Basin	625
Shell Creek near Greybull	645
Bighorn River at Kane	620
Shoshone River below Buffalo Bill Reservoir	225
Shoshone River near Lovell	465
Shoshone River at Kane	695
Clarks Fork River near Chance	107

Compiled from:
Water resource records for Wyoming, part 2, water quality records, U. S. Geological Survey. Data furnished by Wyoming Water Planning Program.

Reservoirs affect the concentration of TDS adversely. Evaporation from the reservoir causes increased concentrations. They generally have a significant beneficial effect in reducing concentrations of suspended

sediments. This effect at Boysen Reservoir is important to the class 1 blue ribbon trout stream fishery for 3 miles downstream.

Irrigation return flows are important contributors of suspended sediment and TDS loads to the lower streams of the basin. Much of the increase of TDS in the Shoshone River from Lovell to Kane is the result of irrigation return flows.

Natural mineralized hot springs are also important contributors of dissolved solids. Much of the increase in TDS in the Bighorn River from Boysen to Lucerne comes from Thermopolis Hot Springs. These are claimed to be the largest such springs in the world. Hot springs on the Shoshone River below Buffalo Bill Dam are important as contributors of TDS. Saline waters from oil wells also contribute dissolved solids to the stream system of the basin.

Description of the quality of the forest environment

Air quality has recently gained increased public attention because the reservoir of air which supports life has steadily deteriorated. Forests influence air quality more than any other land ecosystem. Trees filter dust, ash, and other solids from the air; and they absorb gaseous pollutants such as sulphur monoxide, ozone, and carbon monoxide. Most importantly they act as great users of carbon dioxide. The purity of air in the basin is due in no small part to the forested highlands which enclose the developed valleys and plains.

Ugly is a word that was never written for the Wind-Bighorn-Clarks Fork Basin. From the kaleidoscope of pastels of the desert badlands to the rich cushion of forested areas of the surrounding mountains, one word suffices--spectacular! Except for a few man-made nicks around the edges, a major portion of the forested areas surrounding the basin are primeval and virgin. This is "back-country USA." An infant by geological standards, the land forms are characterized by jagged, soaring peaks and wild, clear, white water streams noisily plunging through the abyss of steep-walled inaccessible canyons. It is an area of rare, priceless, undefiled beauty. Much of the high mountain area is protected by designation as Wilderness, Primitive Area, or National Park. Even those areas of unclassified forested lands remain relatively free of human impact. Low population, inaccessibility, tradition, and lack of demand are the more important reasons why development of natural resources has been kept at the minimum. Any planned development in the Wind-Bighorn-Clarks Fork River Basin should recognize scenic values as one of the most critical environmental concerns.

As important as these physical attributes are, they may not be the basin's most important contribution to environmental quality. Man's environment includes land, water, and air. It also includes sociological institutions, physical, and structural factors such as buildings, traffic, cities, and all living organisms, including man.

The spiritual needs of man are difficult to describe and impossible to separate from the varied aspects of life. We do know that a chance to rest and enjoy a natural environment such as the mountainous wildlands, forests, and badlands of the basin can help contribute to mental and physical health. This type of environment offers unique opportunities to enjoy quietness, solitude, and freedom from the confusion and abstraction of everyday life.

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Man has lived in the Wind-Bighorn-Clarks Fork Basin since prehistoric time. The Medicine Wheel, on Medicine Mountain in the Big Horns, commands a tremendous view of the Bighorn Basin. The wheel is formed of stones laid side by side. They form a circle 78 feet in diameter. Six rock cairns about 2½ feet high are around the wheel. Five of the cairns face inward toward the center of the wheel; the sixth faces outward to the rising sun. Near Meeteetse, on the Greybull River, an arrow about 30 feet long, also formed by laying rocks side by side, points toward the Medicine Wheel. The original purpose of these archeological ruins is not known.

Excavations of Mummy Cave near Cody on the North Fork of the Shoshone River indicate the cave was occupied as long ago as the year 7280 B.C. Mummy Joe, for whom the cave is named, was wrapped in a sheepskin garment. A salvaged piece places his burial in the year 734 A.D. or about 1,238 years ago. All of the cultural layers give evidence that young mountain sheep were the principal food supply for the cave dwellers.

Indian tribes active in the basin were the Sioux, Crow, Cheyenne, Arapahoe, Shoshone, and the Sheepeaters. They ranged along the foothills of the mountains, using the basin primarily as hunting grounds during the summer and fall. The Shoshone occasionally wintered near the Wind River. The Sheepeaters appear to have been the only Indians in residence.

John Coulter, a mountain man and trapper, is generally credited with being the first white man into the basin. About 1809 he was near the present town of Laurel, Montana, with the Manuel Lisa expedition when he was sent out alone to drum up business with the Indians. He went up the Shoshone River to about Cody and described the geyser activity at the mouth of the canyon there. He went north into Sunlight Basin and then east and south to the west slope of the Big Horns. He was near Thermopolis and crossed south into the Lander-Riverton area. He went northwest out of the basin over Togwotee Pass into Jackson Hole.

Ashley's fur traders came down the Wind River in 1827. Captain L. E. Bonneville's rendezvous of 1833 was on the Popo Agie, and Nathaniel Wyeth came through the area the same year. In 1860 Jim Bridger, leading the War Department expedition into Yellowstone Park, went through parts of the basin.

Cattle were brought into the Wind River Valley in 1869, and farming started on a tributary to Red Canyon Creek. Agricultural settlement on the Wind River continued. At the same time large herds of cattle were being brought into the basin forming the first cattle ranches. Commissary activities associated with the ranch headquarters were the start of early communities. The Embar on Owl Creek, the Pitchfork at Meeteetse,

Otto Franck at Otto, Henry Lovell near Kane, and John Luman at Hyattville were early ranches and ranchers.

In 1868 the settlers in the Wind River Valley by formal action set forth the boundaries of Fremont County and ordered the town of Lander to be laid out. Fremont County became the first county in the state to be broken out of the first five counties, and Lander became the first town in the basin. The Federal Government had just signed the Treaty of 1868 with the Shoshone Indians and moved them from the Green River country to the present reservation. The settlers were very upset. Their political action seems to have been an attempt to assert states' rights, rather than a need for local government. Big Horn County was the next county formed. The Bighorn River was the east boundary when the territorial government proposed to carve Big Horn County from parts of Carbon and Sweetwater Counties in 1890. A territorial requirement was a population of 1,500 people within the county. The new county was not able to meet this requirement. In 1896 the legislature moved the boundary from the river to the crest of the Big Horn Mountains. This gave them enough people, and Big Horn County became an entity. Park County in 1909 and Hot Springs and Washakie Counties in 1911 were created from the original Big Horn County.

The Bridger Trail, an alternate to the Bozeman Trail, came north into the Bighorn Basin over Sioux Pass. It came down to the Bighorn River near the mouth of Owl Creek. It roughly paralleled the Bighorn to the Greybull River, went up the Greybull River, over to the Shoshone River, and north to the Yellowstone River.

Daily mail came from Red Lodge to Meeteetse on the Red Lodge Stage. From Meeteetse the stage east was to Fenton, Otto, Bonanza, and Hyattville. South of Meeteetse the road went through Embar on Owl Creek to Ft. Washakie. Mail came from the east through Buffalo, up Clear Creek to Hazelton, down to Ten Sleep, and then north to Hyattville. Another route was from Sheridan over the Big Horns to Spanish Point and down to Hyattville and Bonanza. By 1911 when state highways were designated, the present network of roads was largely established.

The Burlington Railroad was extended south from Toluca, Montana, in 1905. It reached Cowley in 1906. By 1908 Thermopolis had railroad service. The Wyoming and Northwestern Railroad Company built west from Casper to Shoshoni in 1906 and from Shoshoni to Lander in 1907. Surveyors from the Chicago and Northwestern Railroad Company surveyed a line through the Wind River Canyon; but work was stopped at this point, and Lander became the western terminus of the railroad. It wasn't until 1913 when the Burlington Railroad used the earlier surveys and built through the Wind River Canyon that the basin had through train service.

The Wind River Valley was the first agricultural center in Wyoming. In 1883 farmers in the valley harvested 50,000 bushels of grain, receiving star billing in the Governor's annual report. During the period 1870 to 1900 development in the basin was slow. Ranching had settled in with large ranches and small communities along the foot of the mountains. In addition to Lander, the present towns of Thermopolis, Basin, and Cody had been established. The mining activity at South Pass had essentially stopped,

An old tepee ring near the present Boysen Reservoir. Man inhabited portions of the basin as long as 9000 years ago.

The search for gold brought the first settlers into and around the basin.

and no new discoveries had been made. In 1894 the Carey Act was passed, allowing the development of federal lands by construction of irrigation works. At about the same time Mormon colonies from Salt Lake started moving into the basin. By 1905 the Cody Canal at Cody, the Bench Canal at Emblem, and the Bighorn Canal at Worland were developing lands under the Carey Act. By 1907 more than 300,000 acres in the Wind-Bighorn-Clarks Fork River Basin had been segregated for development. A population explosion from 1900 to 1910 more than doubled the population. The new communities of Riverton, Worland, Lovell, Byron, and Powell were started, and the present system of counties was formed.

GENERAL DESCRIPTION

Numerous factors have influenced the economic development of the Wind-Bighorn-Clarks Fork Basin. Population, employment, and income are the more important economic indicators affecting the area as it exists currently. In this chapter these elements are described historically, measured in terms of present status, and projected to the years 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, and education are also discussed.

Much of the information about economic activity and social characteristics was obtained from published materials. Data from secondary sources are generally not available for areas smaller than counties or groups of counties. Therefore, the five counties in the basin believed to be most representative of the basin are used as the geographic unit for economic study. The total area of these counties is slightly larger than the river basin area in Wyoming, but no major population centers were added or deleted by using this delineation. The five counties are: Big Horn, Fremont, Hot Springs, Park, and Washakie.

Population

The population of the study area remained nearly constant from 1920 to 1930, increased about 10,000 persons for each of the next three decades, and then decreased slightly from 1960-70. The 1970 population count was 68,407. Fremont, Park, and Washakie Counties account for nearly all of the population growth during the past 50 years. Total population for the five counties is listed in table III-1. Basin population is predominantly rural, although the residents are becoming more urban-oriented each year. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most sections of the United States. In 1970 nearly 49 percent of the area population lived in urban areas as compared to 21 percent in 1940. One county, Big Horn, had no urban population in 1970. None of the communities is large enough to be classed as a Standard Metropolitan Statistical Area. Riverton, Lander, Cody, and Worland are the largest towns each having a popuation over 5,000. All but Worland showed a sizeable gain during the past decade. Population by rural and urban categories is listed in table III-2.

Table III-1--Total population of Wyoming counties

Counties	1920	1930	1940	1950	1960	1970
Big Horn	12,105	11,222	12,911	13,176	11,898	10,202
Fremont	11,820	10,490	16,095	19,580	26,168	28,352
Hot Springs	5,164	5,476	4,607	5,250	6,365	4,952
Park	7,298	8,207	10,976	15,182	16,874	17,332
Washakie	3,106	4,109	5,858	7,252	8,883	7,569
Total	39,493	39,504	50,447	60,440	70,188	68,407

Source: U.S. Census of Population

Table III-2--Population by rural and urban categories

Category	1940	1950	1960	1970
Urban	10,380	24,747	30,366	33,206
Rural farm	22,283	18,759	14,032	10,612
Rural non-farm	17,784	16,934	25,790	24,589
Total	50,447	60,440	70,188	68,407

Source: U.S. Census of Population

In 1970 there was a total of 23 incorporated communities, varying in size from 25 persons in Lost Cabin to 7,995 in Riverton. Nearly all of the nonfarm population growth since 1940 has occurred in towns larger than 2,500 persons. In table III-3, incorporated towns are listed according to their size class in 1970, thus revealing what changes have taken place during the 30-year period.

The rural orientation of the area is also revealed by population density. There are less than three perons per square mile compared with over three per square mile for Wyoming and about 57 per square mile for the United States. Fremont and Hot Springs Counties contain the Wind River Reservation which is the only Indian Reservation in Wyoming. Two tribes

Those who found no gold began to settle the land. The sod-covered log house was the standard homesteader's residence.

This picture of a tar paper shack and serious wind erosion was taken in 1937 during the settlement of the Riverton Project.

In 1943 the tar paper shack remained, but a planted windbreak had helped heal the land.

PLATE 10

When repayment problems developed on a portion of the Riverton Reclamation Project, the land was purchased by the government; and some settlers abandoned their homes.

An "average" farmstead on an irrigated farm on the Riverton Reclamation Project. The windbreak of planted trees protects homes and reduces erosion.

PLATE 11

Table III-3--Population of towns by size class

Size class 1/	Number of towns	1940	1950	1960	1970
Less than 500	12	2,485	2,683	3,132	2,888
500-999	2	638	1,170	1,340	1,460
1,000-2,499	3	5,102	5,990	6,056	5,469
2,500-5,000	2	4,370	6,674	8,695	7,870
Over 5,000	4	10,380	15,565	21,671	25,336
Total	23	22,975	32,082	40,894	43,023

1/ Population of towns in 1970 determined size class for all years shown above.

Source: U. S. Census of Population

(the Shoshone and the Arapahoe) are located here. At the present time, 6 percent of the total population and 10 percent of the rural people are Indian. The number of resident Indians increased from 3,517 in 1960 to 4,044 in 1970. Nearly 90 percent have a rural status.

From 1960 to 1970, migration patterns have influenced population changes in the study area by a greater amount than birth and death rates. During this decade the five counties had a net out-migration of a total of 10,464 people. Out-migration has had a profound impact on the farm population. Off-farm and out-of-the-basin employment opportunities, coupled with decreased agricultural labor requirements and increased farm efficiency, have resulted in more nonfarm residents and increased out-migration. Net migration rates for the past three decades are shown in table III-4.

Numerous side effects result from population migration. Some age groups are influenced more than others. A large proportion of the losses are occurring in the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of the population from 1960 to 1970 are shown in figure III-1. The population has undergone a maturing process in terms of age distribution.

The Indian population as a whole is quite young compared to the non-Indians. The median age of Indians in the area in 1970 was 20.5 years compared with 27.8 for all inhabitants. More than 60 percent of the Indian population is under 25 years of age as contrasted to 46 percent

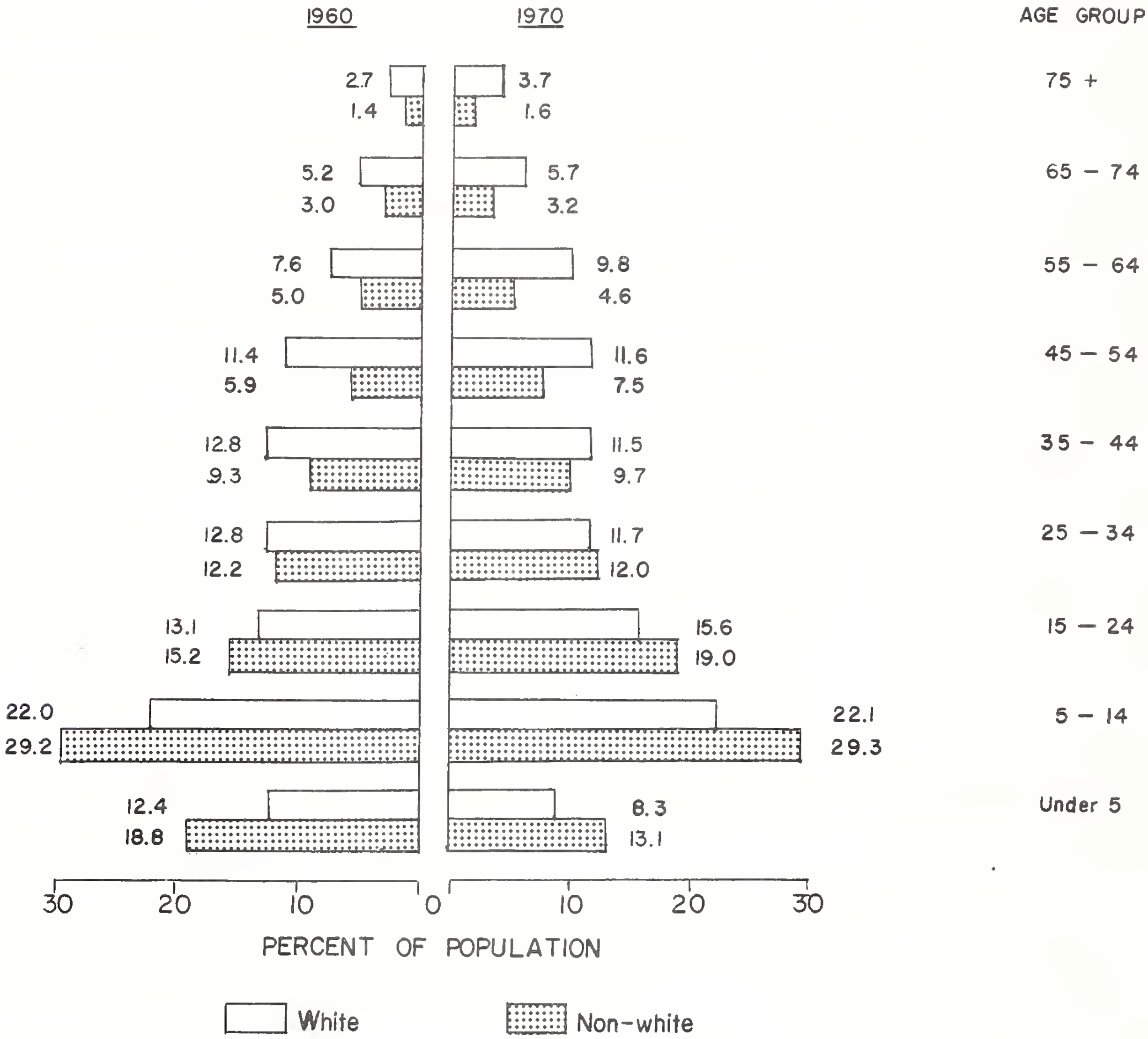
Table III-4--Components of population change, 1940-1970

Component	Big Horn		Fremont		Hot Springs		Park		Washakie		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
1940 population	12,911		16,095		4,607		10,976		5,858		50,447	
1940-50:												
Natural increase 1/	2,333		2,350		652		2,722		1,137		9,194	
Net migration 2/	-2,068	-16.0	1,135	+7.1	-9	-0.2	1,484	+13.5	257	+4.4	799	+1.6
Population change	265		3,485		643		4,206		1,394		9,993	
1950 population	13,176		19,580		5,250		15,182		7,252		60,440	
1950-60:												
Natural increase 1/	2,287		4,127		954		3,380		2,075		12,823	
Net migration 2/	-3,565	-27.1	2,461	+12.6	161	+3.1	-1,688	-11.1	-444	-6.1	-3,075	-5.1
Population change	-1,278		6,588		1,115		1,692		1,631		9,748	
1960 population	11,898		26,168		6,365		16,874		8,883		70,188	
1960-70:												
Natural increase 1/	1,010		4,283		169		2,092		1,129		8,683	
Net migration 2/	-2,706	-22.7	-2,099	- 8.0	-1,582	-24.9	-1,634	- 9.4	-2,443	-27.5	-10,464	-14.8
Population change	-1,696		2,184		-1,413		458		-1,314		- 1,781	
1970 population	10,202		28,352		4,952		17,332		7,569		68,407	

1/ Births to resident mothers minus deaths of residents.

2/ Population change minus natural increase.

Figure III-1--Population distribution in percentages by age group and race, 1960 and 1970--
Wind-Bighorn-Clarks Fork Basin in Wyoming



for the non-Indian population. The difference in age composition between whites and nonwhites (primarily Indians) is shown in table III-5.

Educational achievements for the rural farm and nonwhite population are below comparable figures for the population as a whole. In 1960 the median number of school years completed for persons 25 years old and over were 11.7, 11.2, and 8.7 years respectively for all residents, rural-farm residents, and nonwhite residents. By 1970 comparable educational levels had increased to 12.3, 12.1, and 11.1 years, respectively.

Table III-5--Percent distribution of population by age groups and by race in 1970

Age group	Whites		Nonwhite	
	1960	1970	1960	1970
	percent			
75+	2.7	3.7	1.4	1.6
65-74	5.2	5.7	3.0	3.2
55-64	7.6	9.8	5.0	4.6
45-54	11.4	11.6	5.9	7.5
35-44	12.8	11.5	9.3	9.7
25-34	12.8	11.7	12.2	12.0
15-24	13.1	15.6	15.2	19.0
5-14	22.0	22.1	29.2	29.3
Under 5	12.4	8.3	18.8	13.1
Total	100.0	100.0	100.0	100.0

Source: U.S. Census of Population

Labor force and employment

All persons at 16 years of age are considered to be eligible for participation in the labor force. In addition to employed persons, the labor force includes those unemployed but seeking employment. The percentage of eligible persons who participate in the labor force varies from county to county (table III-6). Part of this variation is due to the availability of continuous employment opportunities, willingness to continue education, and desire to work. The participation rate also varies among age groups. A major portion of the labor force is in the 25-64 age group. This age group is becoming a larger part of the total because there is a tendency for young workers to delay their entry into the labor force because of educational opportunities and training requirements. Also, improved retirement benefits have attracted older workers to consider earlier retirement.

Table III-6--Labor force participation rates and unemployment rates, Wyoming study area, 1970

	Big Horn	Fremont	Hot Springs	Park	Washakie	5 county area
	number					
Persons 16 years of age and over	7,001	18,170	3,494	11,940	4,989	45,594
Persons in labor force	3,921	10,748	1,852	7,109	3,080	26,710
	percent					
Participation rate:						
Male:	76.6	76.7	67.7	80.9	82.6	77.8
Female:	35.9	41.6	39.5	39.4	40.5	39.9
Unemployment rate						
Male:	2.9	7.0	4.0	3.1	4.5	4.8
Female:	6.6	6.1	4.6	7.0	4.9	6.2

Source: 1970 Census of Population

A certain amount of unemployment is inevitable wherever individuals can change jobs. This is a transitional unemployment which is of limited duration. The 5.0 percent unemployment rate of the Wind-Bighorn-Clarks Fork area appears to be little, if any, above the national norm. In addition to the unemployed, there are many persons whose labor is underutilized and whose incomes are below what they might be.

Underemployment differs from unemployment only in that human resources are utilized to some extent. An unemployed person cannot find work, while an underemployed individual can find work but at an amount less than he desires. One cause of underemployment is hidden because some people do not look for jobs. When there is a lack of employment opportunities, they withdraw from the labor force and are not counted as unemployed. Another cause is the immobility of people, especially those above 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the basin area also add to this situation. Fishing and hunting may not be readily sacrificed for added income. Many jobs are seasonal, leaving people unemployed or under-employed at least part of the year. Farming, food processing industries, mining, and recreation may provide only seasonal employment. Employment at the sugar refineries is at a peak for a period following harvest. The tourist trade is limited to the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine whether incomes are below capacity. Income capacities are determined by comparing

selected attributes of the male and female labor force in this study area to like attributes for the nation as a whole. Reported median incomes for the labor force in the study area were then compared with an imputed median income reflecting the earning capacity of segments of the national labor force with similar earnings characteristics. The ratio between these indicators measures the degree of underemployment. In 1960 underemployment rates were 12 percent of the male labor force and 43 percent of the female labor force, for a combined 20 percent of the total labor force. Severe underemployment exists at 20 percent or over. Underemployment as well as unemployment rates are even higher on the Wind River Indian Reservation.

The increase in population from 1940 to 1960 was closely related to the growth in nonfarm employment opportunities. Total employment increased 55 percent during the period despite a continued decrease in agricultural employment as shown in table III-7. Employees of agriculturally related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

Basic industries of the area include agriculture, forestry, mining, and manufacturing. In 1940 they provided 55 percent of all jobs, but by 1970 this percentage dropped to 33. The sizeable increase in mining activities prevented a further decline. Agriculture was the only major industry in which employment declined for the entire 30-year period. There was a sharp increase in employment in the construction, transportation, communications, utility, trade, financial, realty, and service sectors during the 1940's. During the next decade employment continued to grow in most of these sectors, but at a lower rate. Construction was the lone exception, where employment decreased nearly one-third. Employment in this sector continued to decline during the 60's. Agriculture, forestry, transportation, communications, and utilities also had fewer workers by 1970. Although population declined by 1,781, total employment increased by 499.

It should be noted that most, if not all, of the overall growth in employment from 1950 to 1970 reflected an increase in jobs held by women. Female labor force participation rates have been increasing in the study area. One reason for increased participation is farm women generally have not been counted as a part of the labor force, even though they may contribute significantly to agricultural output. However, as farm women seek off-farm employment or as they migrate off farms and obtain jobs, they are counted in the labor force and in total employment. Another reason is the tendency for women who have finished rearing their family to find jobs in service-type industries. More of these jobs are becoming available, and they can often be filled by workers with little specialized training.

Economic activity in the business and manufacturing sectors is shown in table III-8. Trends in the number of establishments vary by industry, but the monetary measurement of business activity is upward for all sectors.

Table III-7—Employment by industry, Wyoming

Industry	1940	1950	1960	1970	Change 40-50	Change 50-60	Change 60-70	Distribution 1960	Distribution 1970
	number				percent			percent	
Agriculture and forestry	7,413	6,585	4,816	3,521	-11.2	-26.9	-26.9	19.4	13.9
Mining	487	1,455	2,870	2,987	+198.8	+97.3	+ 4.1	11.6	11.8
Construction	1,017	2,880	2,015	1,785	+183.2	-30.0	-11.4	8.1	7.1
Manufacturing	865	1,127	1,425	1,908	+ 30.3	+26.4	+33.9	5.8	7.5
Food Prod.	(249)	(281)	(380)	(335)	+ 12.9	+35.2	-11.8		
Lumber Prod.	(168)	(119)	(125)	(199)	-29.2	+ 5.0	+59.2		
Other mfg.	(448)	(727)	(920)	(1,374)	+62.3	+26.5	+49.3		
Transportation, comm. & utilities	644	1,493	1,742	1,528	+131.8	+16.7	-12.3	7.0	6.0
Wholesale trade	255	462	451	674	+81.2	- 2.4	+49.4	1.8	2.7
Retail trade	1,771	2,827	4,110	4,318	+59.6	+45.4	+ 5.1	16.6	17.1
Finance, Insurance, and real estate	174	506	530	622	+190.8	+ 4.7	+17.4	2.1	2.5
Services	2,476	3,453	5,278	6,454	+39.5	+52.9	+22.3	21.3	25.5
Government	551	878	1,015	1,492	+59.3	+15.6	+47.0	4.1	5.9
Not reported	300	335	538	NA	+11.7	+60.6	NA	2.2	NA
Area total	15,953	22,001	24,790	25,289	+37.9	+12.7	+ 2.0	100.0	100.0
Male	13,738	17,613	17,966	16,650	+28.2	+ 2.0	-7.3	72.5	65.8
Female	2,215	4,388	6,824	8,639	+98.1	+55.5	+26.6	27.5	34.2
Wyoming	86,559	114,715	123,309	123,389	+32.5	+ 7.5	+ 0.1	Not applicable	

Source: U.S. Census of Population

Table III-8--Number of business establishments and reported economic activity, 1958-1967

Sector	Unit	1958	1963	1967
Wholesale trade:				
Establishments	No.	138	128	128
Sales	$ million	33.6	32.3	44.8
Retail trade:				
Establishments	No.	838	875	906
Sales	$ million	85.0	98.6	101.1
Selected services:				
Establishments	No.	587	677	660
Receipts	$ million	9.1	14.8	18.5
Mineral industries:				
Establishments	No.	292	304	217
Value of shipments and receipts	$ million	239.1	276.7	264.9
Manufacturing:				
Establishments	No.	75	90 1/	83 1/
Value added	$ million	9.4	16.0	14.9

Source: Census of Business
Census of Manufacturing

1/ Data for Hot Springs County withheld to avoid disclosure of individual firms and not included in totals shown.

In 1967, 61.7 million barrels of crude oil, 546 thousand tons of processed bentonite, 2 thousand tons of uranium (U_3O_8) and 1.5 million tons of usable iron ore were produced in the five county area.

Income

Another measure of economic well-being in an area is personal income. Total personal income for the study area increased from 24 million dollars in 1940 to 225 million in 1970 (table III-9). This is an increase of 842 percent as compared to 775 percent for the nation. Per capita income increased during the same periods. However, in 1970 it was 16 percent below the national average.

Personal income normally increases over time for two reasons. The first is increasing production, which implies rising income. The second source is price inflation. It is important to distinguish between the two influences, because the latter can exaggerate the growth of income during

Table III-9--Personal income and earnings by broad industrial sector, for selected years

Category	1940	1950	1959	1966	1968	1970
	(thousands of dollars) 2/					
Total personal income	23,921	81,965	129,580	170,225	195,537	225,342
Per capita income 1/	476	1,359	1,904	2,538	2,916	3,294
Per capita income comparison to U.S. - 100	80	91	88	86	85	84
Total earnings	20,495	67,012	107,329	136,059	155,931	176,422
Farm earnings	7,997	16,827	17,604	16,185	18,476	15,429
Total nonfarm earnings	12,498	50,185	89,725	119,874	137,455	160,993
Government earnings	3,164	8,837	15,439	24,795	29,256	34,915
Private nonfarm earnings	9,334	41,348	74,286	95,079	108,199	126,078
Manufacturing	1,272	4,409	5,237	11,112	13,621	15,703
Mining	653	4,215	16,930	20,545	25,441	29,333
Contract Construction	959	7,298	10,354	12,413	13,271	15,721
Transportation, Communications, and Public Utilities	991	3,932	7,429	8,603	9,638	10,901
Wholesale and Retail Trade	3,719	14,179	20,005	19,962	21,095	24,107
Finance, Insurance, and Real Estate	262	1,655	2,438	3,613	4,021	4,372
Services	1,444	5,589	11,488	17,990	20,248	24,901
Other	34	71	405	841	864	1,040
	(thousands of dollars) 3/					
Total personal income	60,103	113,055	146,418	174,590	188,742	199,428
Per capita income	1,191	1,874	2,151	2,603	2,814	2,915

Source: Office of Business Economics Information System

1/ Per capita income is shown in dollars

2/ Current dollars

3/ 1967 constant dollars

a period of inflation. Inflation is reflected in rising prices of goods and services, as well as in increased money income to individuals, businesses, and government. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation. Total personal income after adjustment to a 1967 dollar base is also shown in table III-9.

Income per family in the study area is lower than that for Wyoming as a whole. About 10.6 percent of all families had incomes below the poverty level as compared to 9.3 percent in this category for Wyoming. Similar statistics for rural farm families in the study area and the state are 13.7 percent and 12.1 percent respectively. Fremont County with 21 percent showed the highest incidence of below poverty level income for rural farm families in the state. This situation is largely influenced by the rural Indian population on the Wind River Reservation.

Wage and salary disbursements, other labor income, and proprietor's income elements of personal income are combined and referred to as earnings. Earnings account for about 80 percent of total personal income in the study area. Total earnings are shown by major sectors of the economy. In 1940 farm earnings were 39 percent of total earnings but declined to 9 percent by 1970. Meanwhile, earnings from mining rose from 3 percent to 17 percent of the total.

Projections

Total employment in the study area is projected to increase by the year 2020. All of the increase will occur in nonagricultural sectors as agricultural employment will continue to decline. Agricultural employment is projected to be 2,900 in 1980; 2,400 in 2000; and 2,200 in 2020. This is a 40 percent decrease from 1970 to 2020.

Total population is projected to be 119,700 by 2020. This is an increase of about 75 percent from the 1970 population. Population projections are based upon employment projections and estimated employment participation rates. By 2020 it is estimated that the population of the nation will more than double. Estimates of population, employment, and per capita income changes for the projection period are shown in table III-10.

AGRICULTURE AND RELATED ACTIVITY

General

Agriculture is an important segment of the basin's economy. Its importance has been evident historically and can be expected to continue. Despite a decline in the number of farms and farm operators, agriculture is an expanding industry in the area. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides,

Table III-10--Projected population, employment, and per capita income

Item	1970	1980	2000	2020
Population:	68,407	76,600	96,700	119,700
Rural farm	10,612	9,000	7,600	7,000
Employment:	25,289	29,100	37,700	47,900
Agricultural	3,521	2,900	2,400	2,200
Other basic	4,895	5,400	5,700	5,600
Non-basic	16,873	20,800	29,600	40,100
Per capita income 1/	2,915	4,000	7,300	12,900
National average per capita income	3,470	4,765	8,289	14,260

1/ 1967 dollars
Source: Office of Business Economics data and census data adjusted to local conditions.

and larger farm machinery. Further increases in efficiencies are expected through year 2020. Total consumption of agricultural products will expand as population of the study area and the nation increases. Rising per capita income leads to additional expenditures for some food items. As incomes grow, consumers tend to upgrade their diets; and this generally means eating more meat, especially beef. Cattle operations are the most important agricultural endeavor in this area. Most of the beef produced is sold in the form of feeder cattle and calves to out-of-state feedlots. The basin has sufficient resources to increase both crop and livestock output above present levels of production.

According to the Census of Agriculture, the amount of land in farms and ranches is about 5.3 million acres. Livestock producers in the study area also obtain grazing leases and permits on adjacent public lands, and this increases the total amount of land used for agricultural production. Although the total amount of land used for agricultural purposes has remained relatively constant, many other farm characteristics for the study area have been altered during the past two decades as shown in table III-11. The direction of these changes is similar for the nation and the State of Wyoming. Out-migration of the population, particularly the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from those specializing in intensively irrigated row crops to those with extensive livestock operations. In 1969, 22 percent of all units were less than 100 acres in size, while 19 percent were 1,000 acres or larger.

Table III-11--Characteristics of farms

Item	Unit	1954	1959	1964	1969
Farms	No.	3,501	2,953	2,650	2,275
Average farm size	Ac.	1,490	1,843	2,243	2,341
Ownership class:					
Full owner	Pct.	54	48	48	51
Part owner	Pct.	27	33	36	36
Tenants	Pct.	19	19	16	13
Size class:					
Under 100 acres	Pct.	25	20	20	22
100-179 acres	Pct.	25	19	15	13
180-259 acres	Pct.	12	13	11	11
260-499 acres	Pct.	18	22	24	21
500-999 acres	Pct.	8	10	12	14
Over 1,000 acres	Pct.	12	16	18	19
Value of land and buildings:					
Per farm	Dol.	26,492	42,977	74,568	112,275
Per acre	Dol.	20	35	33	48

Source: U.S. Census of Agriculture

The per acre value of land and buildings increased 2½ times between 1954 and 1969. This is partially due to higher land prices and building construction costs, and partially due to other capital investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased farm size has resulted in an average investment of greater than $100,000 per farm. Large capital requirements are also reflected in farm ownership. The percentage of farmers and ranchers who own only a part of the land they operate rose from 27 percent in 1954 to 36 percent in 1969. Meanwhile, those in full ownership and tenant categories declined. Apparently, farm operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Little change can be expected in this trend as farm size, land values, and machinery costs continue to increase.

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugar beet refineries, food processing plants, marketing, and transportation industries are heavily dependent upon the crops and livestock produced locally. The amount of processing performed varies by type of product and can range from a small amount as in the case of feed grains to providing a finished product such as sugar. Farmers and their families are an important source of labor. They can supplement farm income with seasonal, part-time, and in some cases, with full-time jobs.

In 1969, 696 farm operators that sold at least $2,500 of farm products also worked at jobs away from their farm. Over one-half of these operators held a job 100 or more days per year.

Land use and production

There are about 5.1 million acres of agricultural land in the basin that were inventoried during 1967 to determine use and conservation treatment needs.[1/] Most of this privately-owned land is utilized for roughages, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Little additional land will be needed for transportation, urban, and built-up areas in future time periods. Consequently, the amount of agricultural land is expected to remain at the present acreage.

Recent trends in areas harvested for selected crops are shown in table III-12. The acreage of oats, wheat, and beans has declined substantially since 1950. The latter began to subside during the early 1960's and then fell off sharply as farmers began growing malting barley.

Table III-12--Trends in cropland acres for selected years in five county area

Crop	1950	1960	1964	1968	1970
Corn for grain	340	1,350	2,490	2,500	5,000
Corn silage	2,795	9,570	11,200	14,800	15,700
Sugar beets	15,634	21,457	42,397	43,985	41,642
Oats	45,400	31,000	28,600	27,800	29,300
Barley	39,000	30,500	33,200	39,600	52,700
Wheat	14,300	6,190	2,490	2,900	2,350
Dry beans	44,300	43,850	28,370	20,500	13,600
Alfalfa hay	110,900	155,500	159,400	145,500	148,000

Source: Wyoming Cooperative Crop and Livestock Reporting Service, Cheyenne, Wyoming.

1/ Conservation Needs Inventory, Wyoming 1967

Malting barley is a relatively new crop to the basin, but a potential exists for increasing production because the altitude and climate lend to growing a desirable product. It is estimated that nearly 30 percent of all barley produced in 1968 was malting barley. Total barley acreage has increased, but the amount used to grow barley for feed has decreased slightly. Barley, oats, and corn are used primarily as feed by the producers and marketed as livestock or livestock products. The irrigated acres of corn harvested for grain more than doubled between 1960 and 1970. Most of the increase can be attributed to the use of early maturing corn varieties. Total feed grain production in the basin is greater now than before because per acre yields have more than offset any decline in acreage.

Sugar beets is the principal cash crop grown in the basin. Although the amount grown has increased, federal programs have more influence on this crop than any other. Most of the increase occurred following an embargo on Cuban sugar. Nevertheless, sugar imports account for over 40 percent of the total sugar consumed nationally at the present time.

Corn silage is produced on more acres each year. The increase in popularity of this crop is due to development of more favorable varieties that result in high production. Improved methods of storage have also enhanced production. The acres of dry beans in 1970 were about one-fourth the acreage in 1950. Some of the decline is due to changed consumer preferences. Also, competing areas have attracted dry bean production away from the basin. Further, alternative crops that are more profitable are now produced. The acres of hay crops have not changed appreciably during the past decade. Some of the mountain meadows are cut for hay as well as used for grazing.

There are about 539,000 acres now irrigated (including idle land with an irrigation water supply) in the basin. About 117,000 acres are used for pasture, 255,900 acres for harvested roughages and hay, and 70,000 acres for feed grains. There are over 29,000 acres of irrigated cropland with very low production. These acres are scattered among the productive lands and use water inefficiently when it is available. They have water rights and usually are so intermingled with productive lands that they are maintained as irrigated land.

Sugar beets and dry beans are the predominant cash crops on irrigated land, although smaller acreages of wheat, vegetables, 1/ and other crops are also harvested. Climatic conditions, primarily insufficient rainfall, limit the amount of nonirrigated cropland to 4,000 acres. Wheat and barley are the dryland crops harvested. Present and projected land uses on state and private lands are shown in table III-13.

The amount of irrigated land is expected to increase from the present 538,830 acres to 555,300 in 1980; to 571,300 in 2000; and 600,100 in 2020. The additional irrigated land will be used primarily for barley, sugar beets, hay, and pasture. Corn for grain and corn silage acreages will also increase. Livestock production will continue to be of major importance; and additional roughage, grazing, and feed grains will be

1/ Mostly potatoes.

Table III-13--Present and projected land use on state and private lands

Crop	Present 1/	1980	2000 2/	2020 2/
	acres			
Irrigated:	538,830	555,300	571,300	600,100
Wheat	2,500	2,200	1,800	1,500
Barley	42,200	53,000	60,000	63,000
Oats	27,000	22,000	19,700	18,100
Corn Grain	3,100	4,000	5,000	6,100
Sugar beets	41,200	36,000	49,300	61,100
Dry beans	16,700	11,000	11,000	11,000
Vegetables 3/	1,500	1,000	1,200	1,300
Other crops	2,500	2,500	2,500	2,500
Silage	15,000	16,800	18,000	18,000
Alfalfa hay	151,900	159,000	157,500	162,100
Improved grass hay	79,000	79,000	79,000	79,000
Native hay	10,000	10,000	10,000	10,000
Rotation pasture	9,000	9,000	9,000	9,000
Permanent pasture	108,000	120,600	118,100	128,200
Not harvested	29,230	29,200	29,200	29,200
Non-irrigated:	4,070	2,500	2,500	2,000
Barley	1,200	1,000	1,000	1,000
Wheat	1,470	1,000	1,000	1,000
Fallow	1,400	500	500	--
Range	4,170,050	4,155,150	4,139,150	4,110,850
Forest	340,300	340,300	340,300	340,300
Other 2/	61,960	61,960	61,960	61,960
Total 2/	5,115,210	5,115,210	5,115,210	5,115,210

1/ Present cropland use generally represents a 1965-70 weighted average.

2/ Does not include 144,850 acres of water and state and private lands in non-agricultural uses.

3/ Mostly potatoes.

needed. The amount of nonirrigated cropland is quite small and is expected to decrease further. The estimated reduction in rangeland acres is a result of converting nonirrigated range to irrigated cropland. Lands suitable for irrigation on public lands may be available for future irrigation development. However, this was not considered in the projections.

Productivity per acre has been increasing in the past and can be expected to expand further through 2020. Present and projected crop yields

are shown in table III-14. The additional capacity to produce will come about partly through use of improved crop varieties and management, improved fertilizer and weed control applications, and application of measures to conserve soil and water resources. Irrigated and nonirrigated barley yields are expected to increase about 80 percent by 2020. Improved grass hay yields probably will more than double during the same period. Alfalfa hay and sugar beets yields are estimated to increase 54 percent and 73 percent, respectively.

Present and projected production for the major commodities are shown in table III-15. For most crops, present production is a weighted average for the years 1965-70. The estimate of grazing on public lands was obtained through the federal agencies issuing grazing leases and licenses. Currently, public lands provide 33 percent of the grazing resource. Production of livestock commodities was determined by relating inventories and sales for the basin to the state total and converting to units of weight.

Projected production levels for the basin are based upon the national rate of increase (or decrease) for each commodity and time period. These rates were altered upward or downward for some items based upon historical comparisons of significant trend changes between the areas. Upward adjustments were allowed for corn for grain, sugar beets, barley, and oats. Downward adjustments were made for dry beans, wheat, and some of the livestock commodities. Only a minor adjustment was permitted for cattle and calves. National projections are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses of agricultural products.

Most of the agricultural commodities produced in the basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in areas outside the state. The livestock operations in the basin are largely cow-calf and ewe-lamb enterprises that provide feeders to feed-lots. Projections of hay and grazing are based on the amount of each needed to supply adequate roughage.

The amount of roughage from grazing public and private ranges was added to the amount produced on irrigated land and from nonirrigated hay. It was assumed that any additional roughage would come from new hay, pasture, and silage crops. Therefore, the estimated increase in irrigated acres is reflected in these roughage crops. One exception is the use of beet tops. It is assumed that all sugar beet tops will be fed as silage or grazed.

Currently, the amount of grain fed is in excess of production. Although production is projected to increase 41 percent by 1980, 85 percent by 2000, and 126 percent by 2020, a deficit of feed grains will continue. Sugar beet production is projected to increase slightly by 1980 and then more than double by 2020. Production of dry beans will decrease by 1980 and then increase to the present level by 2000.

Beef production is projected to increase 35 percent by 1980 and 135 percent by 2020. Sheep and lamb production is projected to decline by 1980

Table III-14--Present and projected crop yields

Crop	Unit	Present yield per acre	Projected yields per acre 1980	2000	2020	Index (Present = 100) 1980	2000	2020
Irrigated crops:								
Wheat	Bu.	38	42	54	66	111	142	174
Barley	Bu.	63	80	96	113	127	152	179
Oats	Bu.	54	69	85	101	128	157	187
Corn, grain	Bu.	69	85	96	108	123	139	157
Sugar beets	Ton	17.0	19.9	24.5	29.4	117	144	173
Dry beans	Cwt	16.4	20.1	25.2	30.0	123	154	183
Vegetables 2/	Cwt	195	300	350	400	154	179	205
Corn silage	Ton	15.0	18.0	23.2	27.1	120	155	181
Alfalfa hay	Ton	2.8	3.2	3.7	4.3	114	132	154
Improved grass hay	Ton	1.3	1.8	2.3	2.8	138	177	215
Native hay	Ton	1.1	1.3	1.6	2.0	118	145	182
Permanent pasture	FU 1/	1,680	1,980	2,240	2,470	117	133	147
Rotation pasture	FU 1/	2,330	2,690	2,970	3,220	115	127	138
Non-irrigated crops:								
Barley	Bu.	27	34	42	50	126	156	185
Wheat	Bu.	24	30	39	48	125	162	200
Range	FU 1/	123	157	183	198	127	148	161

1/ Feed unit: One feed unit is equivalent to one pound of shelled corn.

2/ Mostly potatoes.

Table III-15--Current and projected production and values of productions

Crop	Unit	Price per unit	Current	1980	2000	2020
Wheat	Bu.	1.73	128,430	122,400	135,900	147,000
Barley	Bu.	.96	2,693,170	4,274,000	5,802,000	7,169,000
Oats	Bu.	.65	1,461,460	1,518,000	1,675,000	1,828,000
Corn, grain	Bu.	1.16	214,310	340,000	480,000	658,800
Sugar beets	Ton	12.17	700,160	716,400	1,207,900	1,796,300
Dry beans	Cwt.	6.27	273,520	221,100	277,200	330,000
Vegetables 6/	Cwt.	1.38	292,500	300,000	420,000	520,000
Silage	Ton	8.00	225,000	302,400	417,600	487,800
Alfalfa hay	Ton	22.00	425,340	508,800	582,600	697,000
Other hay	Ton	22.00	113,700	155,200	197,700	241,200
Pasture	AUM	6.75	449,800	584,573	647,127	768,076
Range	AUM	6.75	1,081,100	1,379,938	1,608,464	1,740,307
Range 5/ (Public land)	AUM	6.75	762,936	768,616	784,849	784,849
Beef	Lb. 2/4/	23.47 7/	106,800	144,420	195,600	251,311
Pork	Lb. 2/4/	15.50 7/	4,500	4,700	4,900	5,000
Sheep	Lb. 2/4/	13.85 7/	15,800	13,400	16,100	18,600
Wool	Lb. 2/	47.00 7/	3,002	2,546	3,059	3,534
Milk	Lb. 2/	.398 7/	40,000	34,000	38,000	42,000
Eggs	Doz. 2/	.39	1,207	990	1,030	1,070
Poultry	Lb. 2/4/	5.00 1/	222	182	190	198
Aggregate value of production	Dol. 1/2/		75,225	91,115	117,757	146,602
Value of feed utilized	Dol. 1/2/		32,151	39,729	46,575	53,542
Gross value of production	Dol. 1/2/		43,074	51,386	71,182	93,060

1/ Current Normalized Price, Interim Price Standards for Planning and Evaluating Water and Land Resources, Water Resources Council, April 1966.

2/ Units in thousands.

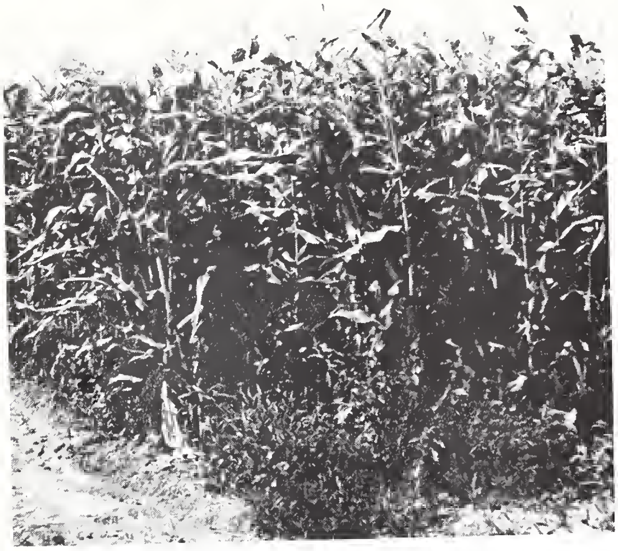
3/ One animal unit month (AUM) = 450 feed units.

4/ Live weight basis.

5/ Grazing obtained through leases and licenses administered by federal agencies.

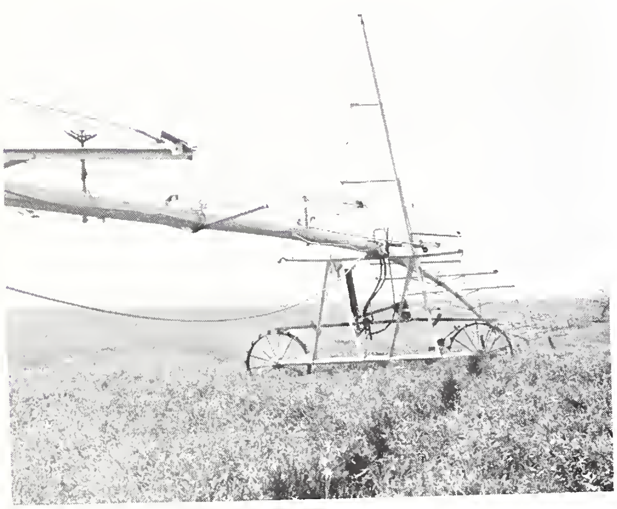
6/ Mostly potatoes.

7/ Prices of livestock products except eggs are for cwt.

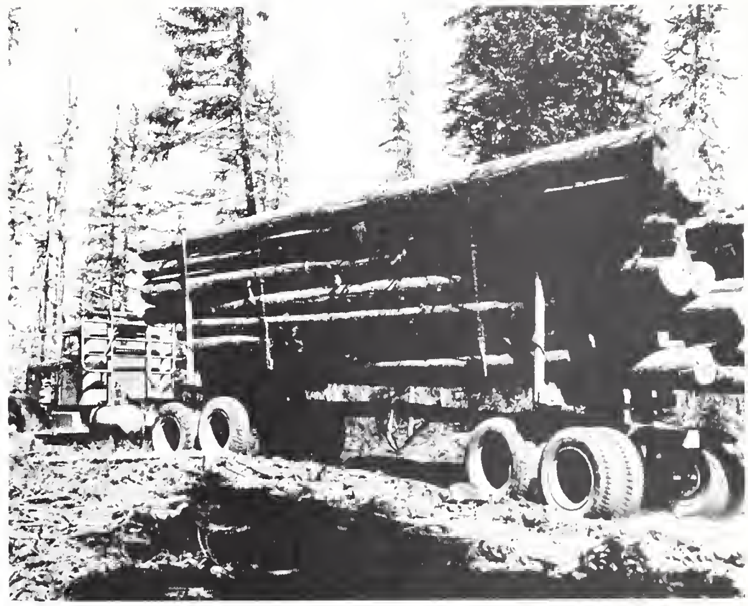


Corn for silage and grain is increasing in importance in the basin

Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management.



Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuited for irrigation under conventional systems.



About 6,000,000 cubic feet of industrial wood products came from the basin in 1962.

U.S. FOREST SERVICE PHOTO

By 1980 the demand for the basin's timber products is expected to exceed the supply by 3,000,000 cubic feet per year.

PLATE 13

and then increase to 18 percent above present output by 2020. Projection of output for pork, wool, milk, eggs, and poultry indicate relatively minor changes from present levels.

There are numerous considerations inherent in making projections for any area. The foregoing projections are based upon national trends and adjusted for local conditions. The demand for goods and services produced from the water and land resources of the basin is influenced by market conditions in other areas. A large part of the agricultural output is exported from the basin. The agricultural commodities produced are not unique to this basin. They are also produced in competing areas throughout the nation and the world. Local producers have little command over the prices they pay or receive. If future cropland yields are underestimated, then less than the projected area of new irrigated cropland will be required to provide the same level of output.

The heavy reliance on nonlocal markets and the competitive nature of local goods and services imposes important economic restrictions on local production. If an excess is produced and marketed, there will be either a decline in prices or an accumulation of surpluses. Large production increases may affect market prices to the extent that net returns to agriculture are reduced.

However, a change in demand for agricultural commodities at the national level will have a similar effect at the local level. Recently there has been a significant increase in international trade. If the increased demand for agricultural products from the U.S. continues, there will likely be a production increase in this basin.

There is the possibility that technology will not be available to increase crop yields to the extent shown in the projections. If crop yields for the irrigated lands are overestimated by 10 percent, an additional 55,000 acres of irrigated land would be needed by 1980 to provide the same amount of output. By year 2020, 60,000 acres more than the presently projected amount would be needed.

The importance of public lands as a source of grazing was indicated earlier. It is assumed that most of the public land will continue to be available to livestock producers. However, if this resource becomes no longer available for grazing there must be an increase in production from private lands. It would require about 175,000 acres of irrigated pasture to replace the amount of grazing that is expected to be produced on public lands in 1980. By 2020 it would take about 143,000 acres of irrigated pasture to replace grazing on the public land.

FOREST RESOURCES AND RELATED ECONOMICS

Timber - supply and demand

In 1970 the Forest Service and other agencies cooperated with the Office of Business Economics and the Economic Research Service to produce

a national assessment of water and related land resources. One result is a projection of national timber supplies and demands to the year 2020 with intermediate projections for 1980 and 2000. The national projections were allocated to major water regions and to subbasins. Use of the projections enables planners to identify the share of national demands which the subbasin is expected to provide and to compare prospective supplies to the demands. In 1962, the base year of the assessment, the Wind-Bighorn-Clarks Fork River Basin[1/] produced about 6 million cubic feet of industrial wood products. The estimated volume of growing stock[2/] available for harvest that year was 12 million cubic feet. By 1980 the demand for timber products from this basin is expected to exceed the supply by 3 million cubic feet or nearly 12 percent. The demand will continue to outstrip the supply by an increasing margin in the future if current levels of management, market prices, and other conditions remain constant or maintain current trends in change (table III-16).

Utilization - volume and value of output

The basin's average annual timber harvest for the 1962-71 period was 29,500,000 board feet or 6,200,000 cubic feet. Table III-17 lists the general locations of this harvest. About 75 percent was harvested from national forests. The remainder comes from state-owned forest land, private lands, the Wind River Indian Reservation, and land administered by the Bureau of Land Management.

About 96.3 percent of the total timber harvest was manufactured into lumber. The remainder was used for railroad ties, mine timbers, house logs, lath, posts, poles, and fuel.

The stumpage value of the 28,410,000 board feet of timber manufactured into lumber was about $146,330 at 1969-72 average prices. Harvesting and transporting timber added to the value of these products. The value added was obtained by deducting the costs of stumpage and of intermediate products (such as fuel and harvesting equipment) from the total value of timber at local points of delivery.

An estimated $475,570 annually was added to the value of timber by harvesting activities. It was assumed that all of this value added could be attributed to the timber industry. Similarly, the value of shipments from primary manufacturing plant reflected the value of manufactured forest products. The value added by primary manufacturing was obtained by deducting the costs of stumpage, logs, fuels, chemicals,

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1/ The boundaries of the subbasin used in the assessment are not exactly identical with the boundaries defined in this report. However, the area of commercial forest land is approximately the same.

2/ Growing stock volume consists of all live trees except live culls, 5.0 inches d.b.h. and larger. (Rough and rotten trees which are alive are not included. Sawtimber is included as a component of growing stock.)

Table III-16--Projected annual volume of growing stock 1/ available and demand for roundwood 2/ in 1980, 2000, and 2020, Wind-Bighorn-Clarks Fork River Basin in Montana and Wyoming 3/

Year	Supply of growing stock available	Projected demand of domestic roundwood
	million cubic feet	
1980	23	26
2000	31	45
2020	31	51

1/ Net volume of growing stock trees removed from inventory by harvesting, cultural operations, land clearing, or changes in land use.

2/ Logs, bolts, or other roundwood sections cut from trees for industrial or consumer uses.

3/ Nearly all of this is in Wyoming.

Source:
U.S. Forest Service and OBERS data prepared for the National Assessment of Water and Related Land Resources, July 1970 and revisions of June 1971.

Table III-17--Average annual timber cut by ownership and product class, 1962-1971

Ownership	Average annual cut		
	Growing stock	Roundwood	Sawtimber
	------thousand cubic feet--		thousand board feet
National forest	4,600	200	21,500
Public domain	insignificant	--	200
Wind River Indian Reservation	1,100	--	5,100
State and private	500	--	2,500
Total	6,200	200	29,300

and other intermediate products purchased from other sectors of the economy from the total value of shipments. The average annual value added by manufacturing was estimated to be $548,710. A portion of the value added (3.5 percent) could be attributed to other sectors of the economy. Thus, the value added, which was attributable to timber, was about $529,500 annually. The total value of timber in the basin's economy was the sum of stumpage and value added by harvesting and primary manufacturing. This was estimated to be $1,170,600 annually.[1/]

Employment and income

In 1960 logging and forest products manufacturing firms employed 125 persons. In 1971 nine firms had employed a sum of about 180 production employees and 40 clerical and managerial employees. Because the projected annual cut of timber in the basin (see table III-18) is not significantly different from that of the past, employment should decrease as labor-saving technology is introduced.

Table III-18--Projected annual cut of timber in the basin

Source	Amount
	--thousand board feet/ year--------
National forest land [a/]	
Bighorn National Forest	16,000
Shoshone National Forest	6,000
Bureau of Land Management land [b/]	200
Land in Wind River Indian Reservation [b/]	200
State and private forest land [c/]	2,500
TOTAL	25,900

a/ Information provided by national forests.

b/ Information provided by Soil Conservation Service.

c/ 361,000 acres of state and private forest land. Assume 70 percent of this is commercial (based on total basin acreage ratios). Then 252,700 acres are assumed to have an average annual cut of 10 board feet per acre per year.

1/ The estimates of value added were based on ratios derived from data presented in USDA Mscellaneous Publication 941, The Economic Importance of Timber in the United States.

Recreation on forest lands

The forest lands in the basin have a large supply of high quality recreation resources. The major recreation activities are sight-seeing, camping, resort use, hunting, and fishing. The influx of recreationists has an important impact on the local economy. A California recreation study [1/] estimated that campers, day-users, motel and lodge guests, and mountain home occupants averaged per capita daily expenditures of $1.48, $1.62, $8.95, and $1.76 respectively. Sales to visitors do not represent the entire impact of their spending on the local economy. The total impact must include income and employment effects on the local economy.

Recreation use is expected to increase substantially by 2000 and 2020 because of national population growth and increased participation rates. About 80 percent of the total use is expected to occur on weekends and holidays. Striving to meet these peak demands may not always be economically attractive. Patterns and types of recreation uses are changing rapidly.

RELATIONSHIP OF ECONOMIC DEVELOPMENT AND WATER RESOURCES DEVELOPMENT

Land and water resource developments for use in agricultural production were virtually unknown in the basin until the 1880's and 90's. The first were irrigation works built by individual farmers followed by developments made possible through the Carey Act. During this time, some of the land was denuded of its virgin cover and planted to vegetation that had water requirements greater than the amount available through the normal supply of rainfall. Sugar beets, dry beans, alfalfa hay, and feed grains were no longer alien to this arid basin.

Crop production from irrigated lands became a progressively larger share of total agricultural production as more areas were irrigated. Currently, over two-thirds of the value of the basin's agricultural output can be attributed to the 538,800 acres receiving full or supplemental supplies of irrigated water. Both private and public investments have been put to use during the era of irrigation development. Private developments contain about 331,200 acres or 61 percent of the total irrigated land; the remaining 207,600 acres are within Reclamation and Bureau of Indian Affairs projects.

National benefits can accrue as a result of future development of water and related land resources. These benefits may be in terms of savings in the cost of producing agricultural products or in terms of improved income. Regional economic benefits are generally more obvious. Additional employment opportunities and increased income may follow water resource development in an area. However, from the national point of view, the amplification of one area's economy may be neutralized by corresponding declines in other areas.

1/ R. Drake, et al. Selected Economic Consequences of Recreation Development: Tuolumne County, Case Study, Agricultural Extension Service, University of California, Berkeley, No. 68-4, June 1968, 66 pp.

RESOURCES FOR RECREATION

Nearly all of the public and most of the private land and water areas in the basin are available for outdoor recreation. Trespass laws and other laws generally require the landowner's permission to use private lands for this or any purpose. User fees are often charged for the use of both private and public property or facilities. Profit and nonprofit indoor recreation facilities are generally available in the basin's larger towns.

The income from recreation activities in the basin is reflected in Table III-9, mainly in the entries for "Services" and "Other." Some of the "Wholesale and retail trade" is also the result of recreation activities. There is no way of knowing for sure, but the income to the basin in Wyoming from outdoor recreation is probably about $8,600,000 per year. Thus, it would rank first among the services and behind government, mining, wholesale and retail trade, construction, manufacturing, agriculture, and utilities and ahead of forestry as an income category.

To avoid unnecessary duplication in this report, most of the discussion about recreation is presented in Chapter V.

Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS

PLATE 14

WYOMING TRAVEL COMMISSION PHOTO

Winter recreation use of national forest lands is rapidly increasing.

SCS PHOTO

PLATE 15

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

The water and related land resources of the Wind-Bighorn-Clarks Fork River Basin are affected by both natural and people-made processes which tend to reduce the quality of or destroy those resources. Other problems are caused by an imbalance of resource availability such as a shortage of irrigation water. This chapter discusses those processes and imbalances, the problems they create, their magnitude, and effect.

EROSION DAMAGE

Erosion damages occur in varying degrees throughout the basin. The two most important types are streambank and gully erosion in the valley alluvium. Approximately 90 percent of the basin's erosion damage occurs in the soft sedimentary rocks on the basin floor and the alluvium in the valley bottoms. Some of this erosion has occurred because modern man has disturbed the vegetation and water flow patterns in the basin.

There is some erosion on forest and rangelands. Erosion is accelerated on these lands by off-road travel by four-wheel drive vehicles, inadequate logging roads and skid trails, fires, overgrazing, and mining. Many miles of inadequately maintained trails are a problem on the Wind River Indian Reservation.

It is estimated that 70,000 acres in the Wyoming portion of the basin have been seriously damaged by erosion in modern times. It is also estimated that about 270 acres are lost annually to gullying and streambank erosion. Over 1,200 miles of streambank are affected each year. Other types of damage also occur to bridge abutments, highways, railroads, canals, fences, and other works of improvement.

The economic and social costs of erosion in the basin are loss of productive land, reduction of crop and forage production; reduction of wildlife, wildlife habitat, recreation, and aesthetics; decrease in farming efficiencies and value of land; and increased cost of operation, maintenance, and construction of transportation and communication facilities.

SEDIMENT YIELD AND DAMAGES

Sediment damages are generally light, but do occur with varying severity throughout the basin. Agricultural lands, stream and river channels, fish and other aquatic life, municipal and irrigation water supplies, capital improvements, reservoirs, and aesthetic values are all damaged by sediment. A sediment yield map is shown in figure IV-1. Sediment yields vary with the geologic parent material in the area. This relationship is shown in table IV-1. For example, 10 percent of the basin is underlain by igneous rock. This area yields 40 percent of the basin's water and .5 percent of the basin's sediment.

Most sediment damages to agricultural lands occur in the irrigated valleys. About 2,500 acres of agricultural land experience some sediment damages annually. Nearly all of the sediment damage on these lands is associated with flooding from nearby streams.

Table IV-1--Relationship of geologic formations to water and sediment yield

Type of parent material	Basin area	Total basin yield	
		Water	Sediment
	------------	------------percent	------------
Pre-Cambrian igneous	10	40	0.5
Paleozoic and mesozoic sedimentary	35	15	10.0
Tertiary pyroclastics	15	35	12.0
Tertiary sedimentary	25	8	17.5
Quaternary alluvium	15	2	60.0

About 2,000 miles of canals and laterals are damaged by an average of 550,000 tons of sediment annually. At about $.40 per ton to remove it, this amounts to an annual cost of $220,000 to owners in the basin. Sometimes this sediment causes delays in irrigation water deliveries. Sediment carried in canals and ditches is also deposited on fields lowering production and increasing operation costs.

Sediments reduce stream capacities and increase flood hazards. Sediment deposits also promote stream meandering, which causes increased land loss due to bank cutting.

Sediments in the streams can suffocate fish, reduce fish reproduction by covering spawning beds, or starve them by reducing their food supply. Other aquatic life may be similarly affected. This problem is serious enough in the Clarks Fork Subbasin because of high sediment content in the water from the Sand Coulee to attract the attention of fisheries biologists, fishermen, and other citizens and officials.

The rivers in the basin are sources of water for a variety of recreational, domestic, industrial, irrigation, and municipal uses. These

Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks.

Inadequate control of irrigation tailwater can cause gully erosion.

Checking the depth of sediment deposits in Boysen Reservoir.

The town of Lander had serious floods before the river channel was cleared. The threat of an occasional flood still exists.

Floods in urban areas disrupt business as well as damage property.

PLATE 17

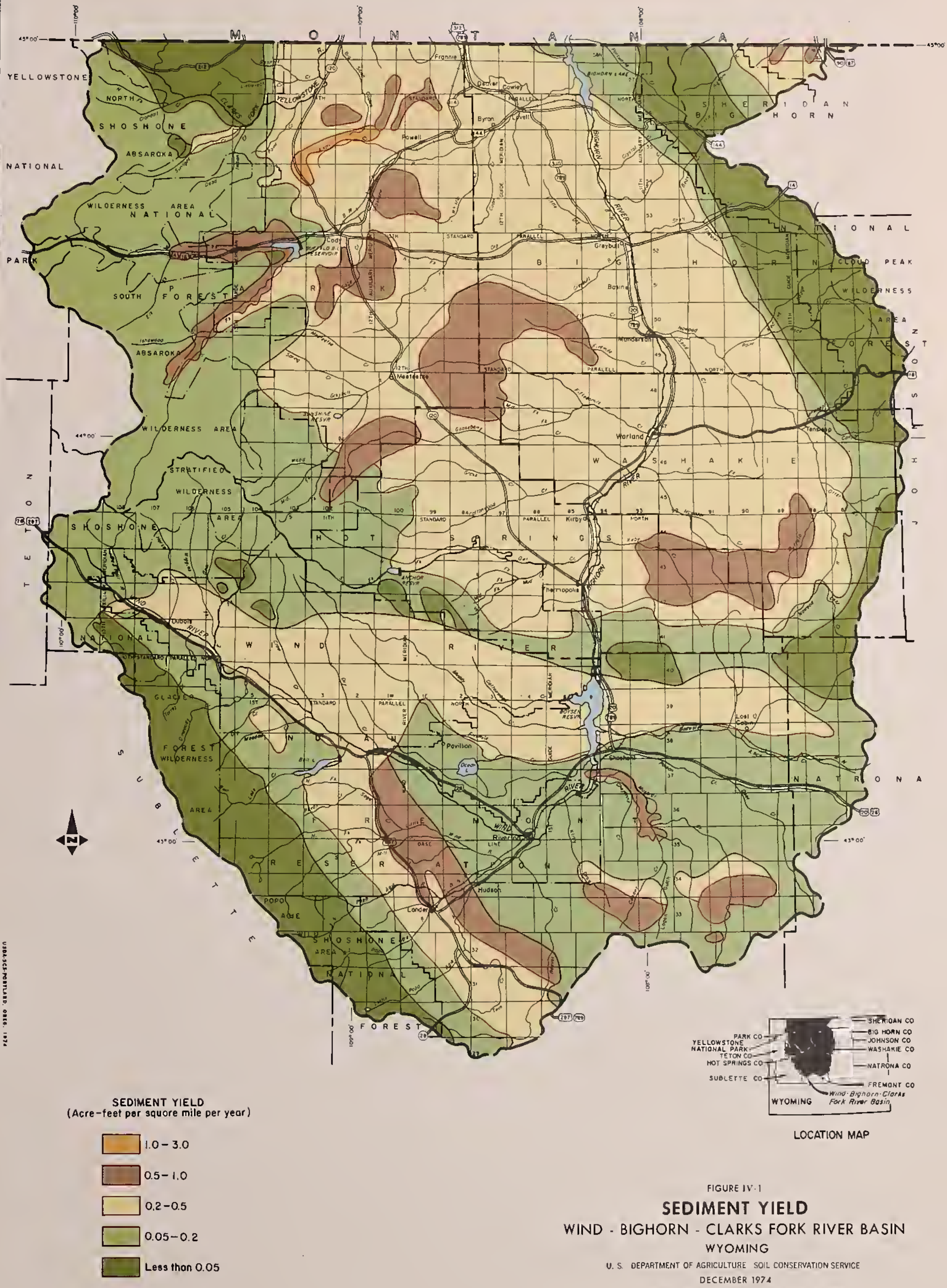


FIGURE IV-1

SEDIMENT YIELD

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND, OREG. 1974

M7-N-22780L

uses are made more expensive in parts of the basin where the stream sediment load is heavy. Sediment usually must be removed before the water is usable. This is costly, and the sediment acts as an abrasive on pumping and control equipment, increasing the cost of maintenance.

Many kinds of capital improvements are damaged by sediment deposition. These include highway and railroad bridges which sometimes need to be raised or relocated due to channel capacity loss. Other permanent improvements such as streets, highways, and buildings are subject to damage by sedimentation.

Streams and rivers in the basin continually transport sediment in various amounts to reservoirs. The sediment is trapped in the reservoirs and reduces their water storage capacity. Table IV-2 lists estimated sediment yields to major reservoirs in the basin. In addition to tangible and environmental damages, excess sediment adversely affects the aesthetics of the streams.

FLOODWATER DAMAGES

Rare weather conditions, such as intensive summer storms or rapid snowmelt, will cause flood damages of varying degrees throughout the basin. However, severe flood damages are relatively infrequent. When smaller floods occur, they generally inundate only low valued properties and may actually have a beneficial effect on range or pastureland.

Table IV-2--Sediment yields to mainstem Bureau of Reclamation reservoirs based on suspended loads and/or reservoir surveys.

Reservoir	Average annual sediment yield	
	Total	Per square mile
	acre-feet	
Boysen Reservoir	1,398	0.18
Bighorn Reservoir		
Bighorn River yield	3,525	0.41
Shoshone River yield	746	0.50
Buffalo Bill Reservoir	708	0.48

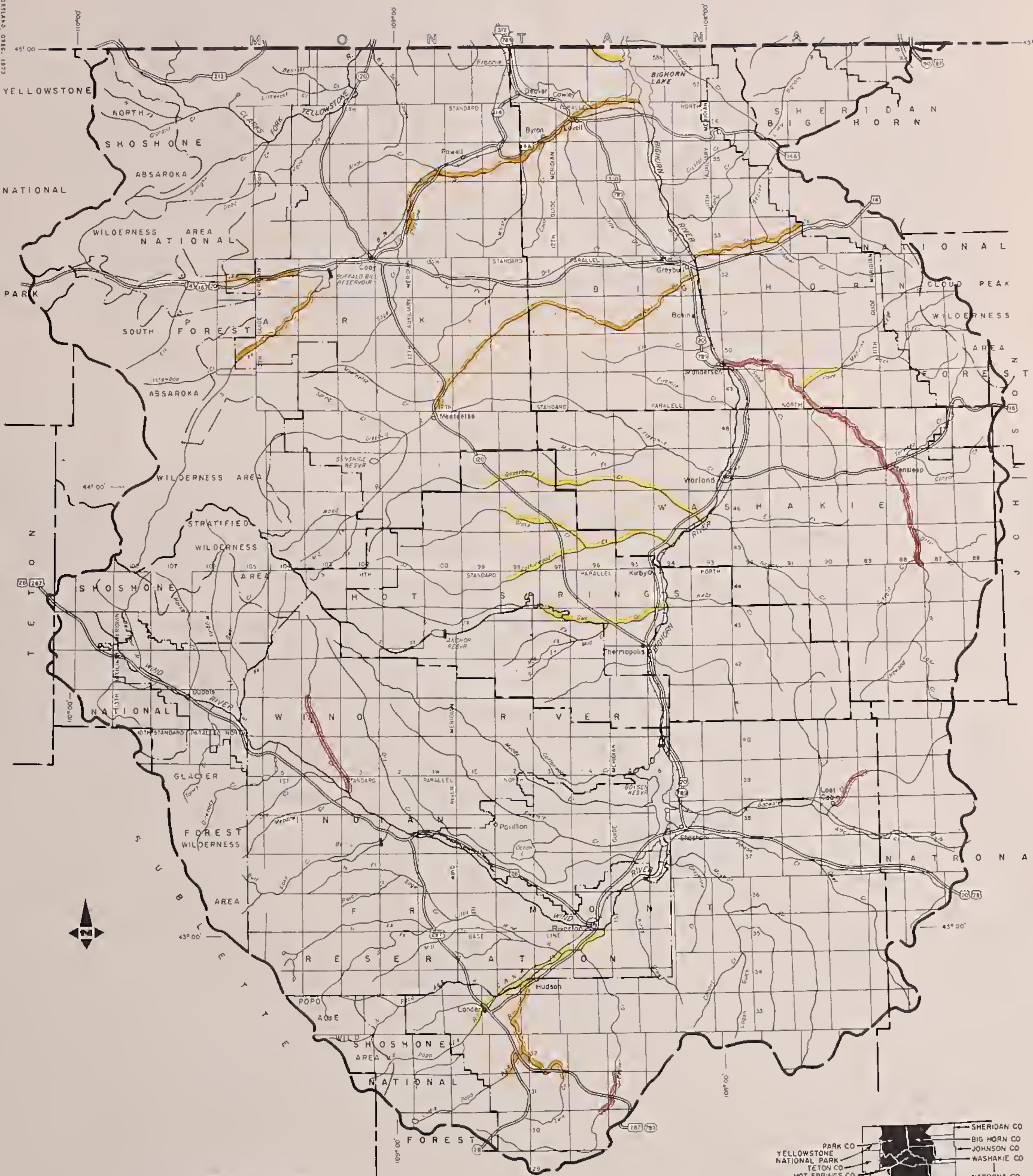
Agricultural properties along Crow Creek, Little Popo Agie, Upper Badwater Creek, Nowood River, Greybull River, Shell Creek, and Shoshone River are flooded frequently. Floodwaters in these areas have destroyed or severely damaged irrigation diversion structures. The delay in water application to the lands the structures serve causes reduced yield on lands outside the flood plain. Within the flooded areas crop yields are reduced. The most serious damage is usually to alfalfa and other hay crops. When floodwaters inundate these crops for prolonged periods, the plants are destroyed, and the crops must be reestablished. Thus, the damage is sustained for more than one year. Farm roads and bridges along the creek bottoms are often damaged or destroyed. Other agricultural damages occur to fences, stored hay, buildings, and machinery. Figure IV-2 is a map showing floodwater problem areas.

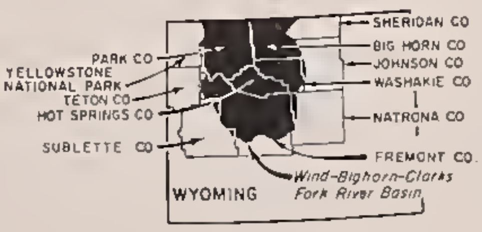
The most serious general flood occurred in 1923 when heavy rains continued over a sustained period with amounts up to 4 inches and caused general flooding throughout the basin. Flood occurrences of recent years are listed in table IV-3. Major floods occurred on several creeks in 1962, 1963, and 1967. Table IV-4 lists estimated average annual flood damages on four selected areas. The Nowood River area includes parts of seven watershed size areas. The other three are single watershed size.

The most serious rural flood problems occur along Shell Creek and along the Greybull and Shoshone Rivers. Some flooding occurs in these areas nearly every year. Higher flows inundate croplands and severely erode the banks damaging irrigation structures. Lands along the lower benches are left idle because of the frequent flood threats. The floods usually occur in June from a combination of snowmelt runoff and spring rain.

The most serious urban flood problems occur in Hudson, Lander, and Manderson. Both the Little and Middle Popo Agie Rivers have caused flood problems in the small town of Hudson. Because the town population is small and the value of property in the flood plain is relatively low, the average annual damage is only about $5,200. The most serious recent flood occurred in 1962 when 47 homes were damaged. Damages from that event were estimated to be about $52,000.

The town of Lander has had at least two serious floods from the Middle Popo Agie River, but because of the threat of flooding, the city has taken action to improve the hydraulic characteristics of the river channel through the city. Lander probably spends more each year for this flood control than any other town in the Wyoming part of this river basin. As long as this practice is maintained, only very rare floods can cause serious damage. New curbs and gutters and street paving have also improved the town's flood resistance. There are some lower lying properties along the river which should never be allowed to develop with new permanent dwellings or buildings of any kind. To allow this would be to further restrict the floodplain and make existing property more susceptible to flood damage.





LOCATION MAP

FLOODWATER PROBLEM AREAS

Floods occur frequently; damages are moderate to severe. A potential flood protection or multiple-purpose project has been identified.

Floods occur frequently; damages are moderate to severe. Physical characteristics, i.e. lack of storage sites, prohibit protection projects in the near future.

Flooding problems exist; damageable values are low to moderate; preliminary studies have been made, but no feasible protection project has been identified.

NOTE: Red areas based on W.I.R.'s and watershed investigation studies. Orange and yellow areas are based on watershed investigation and newspaper accounts.

FIGURE IV-2

FLOODWATER PROBLEM AREAS
WIND - BIGHORN - CLARKS FORK RIVER BASIN
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Floods in rural areas damage roads, buildings, and cropland.

PLATE 18

Some land with impaired drainage is presently cropland with limited production.

Most of the land described as poorly drained is presently of little use to either agriculture or wildlife.

Table IV-3--Occurrence of major floods on selected watersheds, 1960-1970.

Watershed	Year										
	60	61	62	63	64	65	66	67	68	69	70
Crow Creek				M 1/		S 2/					
Little Popo Agie River			S	S		S				M	
Candy Jack	S		S	S				S			
Badwater Creek				M				M	S		
Nowood River			S	M		M		S			S
Greybull River		M	M	S	M	S		S	M	M	M
Shell Creek		S	S	S	M	S		M	S	M	M
Shoshone River		S	S	S		S		S	M		

1/ M = Moderate flooding - These floods were serious enough to be reported in local newspapers.
2/ S = Serious flooding - These floods were serious enough to merit special effort in reporting by the editor of the local newspaper.

Compiled from local newspaper accounts.

Both the Nowood and Bighorn Rivers have caused flooding in the small town of Manderson, which lies in the floodplain at the confluence of the two rivers. Average annual damages have been estimated to be about $39,500, of which 60 percent are from the Nowood and 40 percent from the Bighorn River.

Estimates of total flood damages in the entire basin were made for the Comprehensive Framework Study, Missouri River Basin. The estimates by subbasin are shown in table IV-5.

IMPAIRED DRAINAGE

All of the irrigated areas in the basin contain some wetlands. These areas are located on the floodplains and terraces along the larger streams. The wet condition is caused by impaired drainage associated with heavy soils or other soil barriers. This condition and lack of gradient restricts

Table IV-4--Estimated average annual flood damage on selected drainages

Major drainage	Flood-plain	Average annual damage				
		Crop & pasture	Other agricultural	Urban	Indirect	Total
	--acres--	dollars				
Crow Creek	40	170	9,580		975	10,725
Little Popo Agie	2,300	16,750	8,650	5,200	3,300	33,900
Upper Badwater	250	420	880		130	1,430
Nowood River	5,900	26,000	39,000	39,510	12,430	122,840

Table IV-5--Summary of current and projected flood damages 1/

Subbasin	Area subject to flooding	Average annual flood damage: Under current economic development	Under projected economic development (w/out flood protection) 2/: 1980	2000	2020
	-1,000 acres-	-----------1,000 dollars-----------			
Clarks Fork Subbasin					
Main stem	.04	1	2	3	4
Tributaries	1.16	0	0	0	0
Subtotal	1.20	1	2	3	4
Wind River above Boysen					
Main stem	30.9	101	171	293	501
Tributaries	24.7	67	104	156	237
Subtotal	55.6	168	275	449	738
Bighorn River below Boysen					
Main stem	38.4	182	323	677	1,314
Tributaries	37.3	118	187	332	572
Subtotal	75.7	300	510	1,009	1,886
TOTAL	132.5	469	787	1,461	2,628

1/ Price base: 1964 price levels for agriculture, 1960 price levels for urban and "other rural."
2/ MRB data adjusted to reflect recent population projections.

the movement of water from the wet area to the drainageways. The wet areas are recharged by canal seepage, overapplication of irrigation water and precipitation. The depth of the water table is governed by the topography, transmissibility of the soils, rate of recharge, and depth and configuration of the underlying bedrock.

Salinity is associated with waterlogging and is aggravated by capillarity in the problem areas. Soil texture, hydrological properties, salinity, and temperature govern the height of capillary rise. Waterlogging and salinity problems will normally occur when the water table is within 4 to 5 feet of the surface. Many miles of tile and open drainage systems have been constructed. These systems have been installed in organized drainage districts and also outside of these districts with various types of federal technical and financial assistance.

There are approximately 98,000 acres of wet and/or saline lands in the basin with the water table less than 6 feet below the surface. The Little Wind-Popo Agie area contains approximately 4,500 acres, the Wind River about 2,500 acres and the Riverton-Midvale-Muddy area about 37,000 acres of wet or saline lands. There are about 6,000 acres along the Bighorn and its tributaries excluding the Greybull and Shoshone Rivers. The Greybull River, including Emblem Bench, contains about 31,600 acres and the Upper Shoshone about 4,200 acres. The Lower Shoshone River and Sage Creek areas near Lovell contain about 11,500 acres of waterlogged and saline land. There are less than 500 acres of this type of problem area on the Clarks Fork and Little Bighorn Rivers. These data are estimates from an analysis of basic data as prepared for the 1970 Wyoming Conservation Needs Inventory. Figure IV-3 is a map of impaired drainage areas in the basin.

WATER SHORTAGES

Agricultural

Nearly all irrigated lands depend on stream flows for their irrigation supply. However, streamflow supplies are not generally concurrent with irrigation demands. Most of the streamflow comes from snowmelt from the higher elevations. The crop growing season in the lower elevations begins before high elevation snowmelt begins and continues after most of the snow has melted. The peak streamflow occurs as much as 10 weeks before the crops reach their peak water use rates, and then recedes more rapidly than the use rates. The problem that results is illustrated in figure IV-4 which shows demand-supply curves for a dry year in the Upper Nowood River area.

Irrigated croplands supplied with water from the larger streams have a good water supply, but late season water shortages still exist. One way to reduce these shortages is to provide reservoir storage of early season high flows for diversion later in the season. Buffalo Bill and Boysen Reservoirs have essentially satisfied the need for storage for

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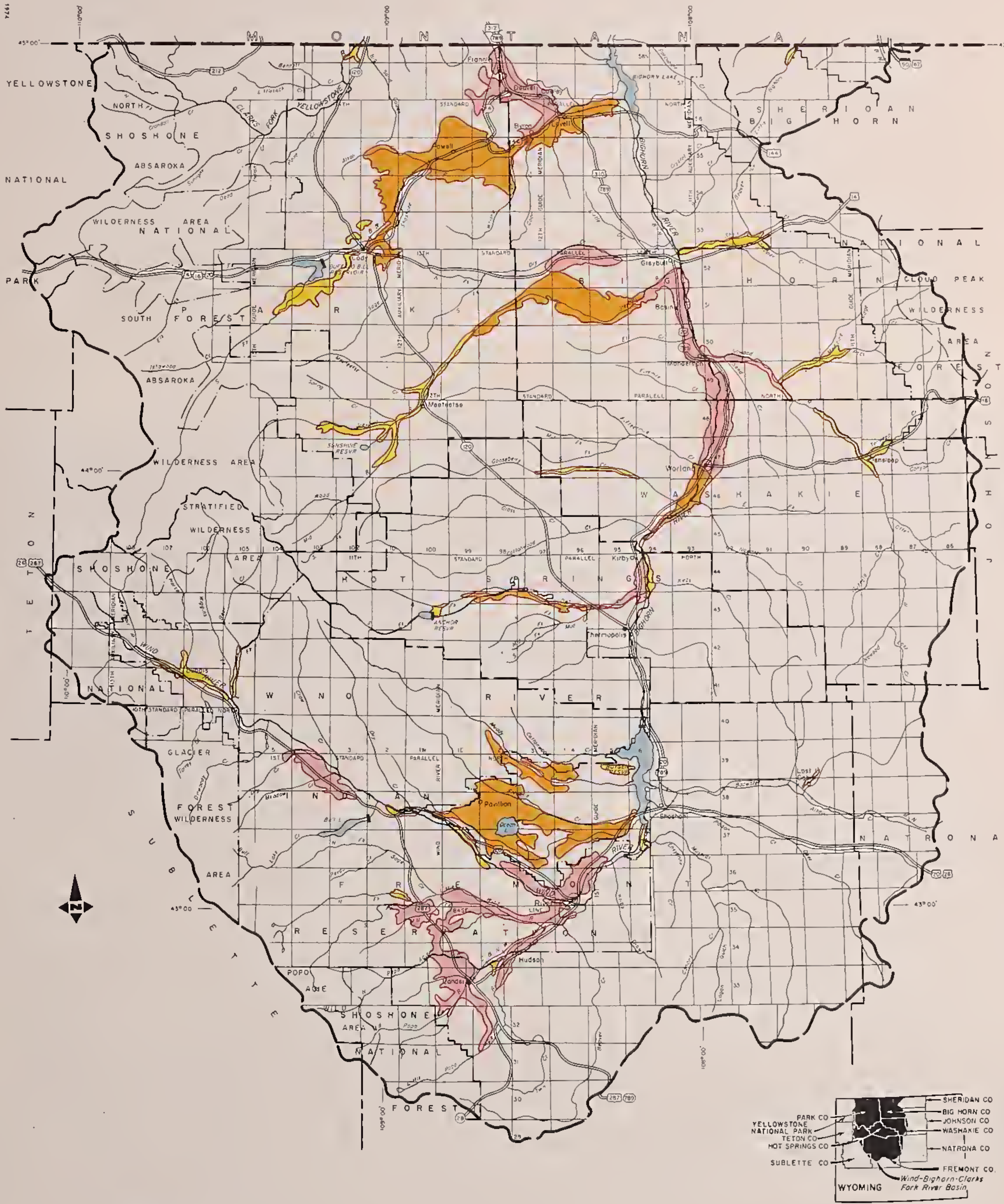


IMPAIRED DRAINAGE
(percent of irrigated land with impaired drainage problem)

- 5% - 10%
- 10% - 25%
- 25% - 50%
- Over 50%
- Water

FIGURE IV-3

IMPAIRED DRAINAGE AREAS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

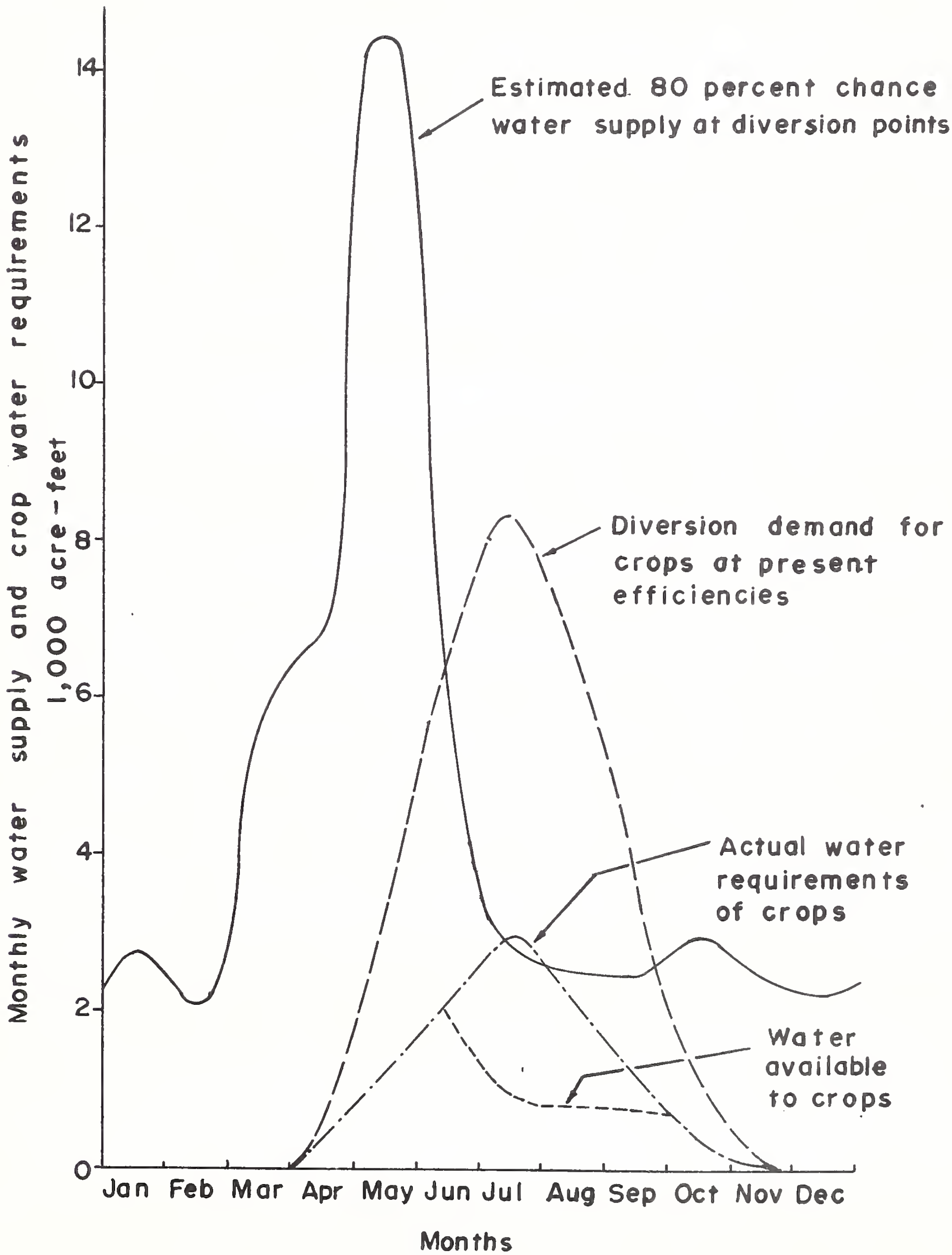
10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22780K

Figure IV-4--Water supply and irrigation demand for the Nowood River above Tensleep, Wyoming



presently irrigated lands along the main stems of the Bighorn and Shoshone Rivers. Bull Lake and Pilot Butte Reservoirs serve the Riverton Reclamation Project. Water shortages that remain on lands served by these reservoirs exist largely because of inefficiencies in transportation and application of the water. In other large tributaries, irrigation water shortages are so small or potential storage sites would be so expensive that no sizeable storage facilities have been built.

In many of the small stream valleys, the annual streamflow is less than than the annual diversion requirements for full irrigation of present cropland. On a few streams the total annual streamflow would not supply these requirements if the water were used at 100 percent efficiency. This situation exists because landowners have developed their cropping patterns to use the early season high streamflows to increase total crop production, even though these crops suffer greatly reduced yields later in the season. The crops are generally hay crops which are cut only once a year. Increased water application efficiences will not significantly increase production in these areas unless additional late season water can be supplied. The situation might be improved and production increased through storage, but economical, geologically favorable, and large enough sites are generally not available. Some source of water must be obtained through intrabasin transfer or ground-water development if existing croplands in these areas are to have a full irrigation supply. In some instances, a water transfer could make a presently uneconomic reservoir site become economically attractive.

Table IV-6 shows a comparison of water supplies to water requirements for presently irrigated lands at present estimated project efficiencies for a median water year and a dry year. In dry years, which occur less than 20 in each 100 years (80 percent chance) there is a shortage of more than 359,960 acre-feet of irrigated water. If feasible storage sites could be provided, about 185,410 acre-feet of water could be stored from the spring runoff within water-short subareas in the basin. This means that at least 174,550 acre-feet would have to be transported from water-surplus areas to water-short areas if a full irrigation is to be supplied.

A related agricultural water management problem is the antiquated condition of irrigation distribution systems. Many existing facilities have deteriorated to the point of being barely usable, and they require much maintenance annually. Other facilities are simply obsolete, and the addition of modern control structures would allow improved transportation and management efficiencies. About 40 percent of presently irrigated lands are served by systems which are partially deteriorated, inadequate, or obsolete.

Livestock water and rural domestic shortages

Most ranch facilities are located near water supplies that are reliable even in periods of drought. Some of these supplies are of marginal quality and can be improved with treatment where economically feasible. The water storage problem is related to grazing management.

Table IV-6--Water supply shortages on presently irrigated land at present efficiencies

Name of hydrologic subarea	Watershed numbers	Present area of irrigated land	Irrigation water diversion requirement 1/	50 percent chance: Present water diversions 2/	50 percent chance: Need for stored or transferred water 3/	50 percent chance: Water supply at upper division point	50 percent chance: Storable water within water-short subareas 4/	50 percent chance: Transfer needs	80 percent chance: Present water diversions 2/	80 percent chance: Need for stored or transferred water 3/	80 percent chance: Water supply at upper division point	80 percent chance: Storable water within water-short subareas 4/	80 percent chance: Transfer needs
		----acres--	-acre-feet-	----------acre-feet----------					----------acre-feet----------				
Wind River above Dubois	14e1-1	1,996	8,290	8,290	0	126,900	-5/	0	8,290	0	104,900	-	0
Horse Creek	14e1-1a	2,423	10,000	10,000	0	47,000	-	0	10,000	0	43,000	-	0
Jakey's Fork, Torrey Crk, & misc.	14e1-3	1,120	4,640	4,640	0	179,600	-	0	4,640	0	170,600	-	0
North and East Fork Wind River	14e1-4	1,872	7,760	7,760	0	181,700	-	0	7,760	0	142,700	-	0
Dinwoody and misc. Creeks	14e1-6	12,018	58,000	58,000	0	160,000	-	0	58,000	0	134,000 6/	-	0
Mainstem Wind River above Burris	-	1,317	6,600	6,600	0	632,300 6/	-	0	6,600	0	532,300 6/	-	0
Crow Creek	14e1-5	1,975	9,700	7,240	2,460	16,000	2,760	0	5,940	3,760	11,000	5,060	0
Bull Lake Creek	14e1-7	725	3,830	3,830	0	192,400	-	0	3,830	0	156,400	-	0
Mainstem Wind River- Burris to Crowheart	-	1,958	9,700	9,700	0	889,400 6/	-	0	9,700	0	743,400 6/	-	0
Dry Creek	14e1-8	521	2,700	1,910	790	4,330	2,320	0	1,450	1,250	2,670	1,220	30
Mainstem Wind River- Crowheart to Riverton	[illegible]	7,270	42,200	42,200	0	628,400 6/	-	0	42,200	0	466,000 6/	-	0
Riverton area canals	14e1-10	20,695	94,400	94,400	0	336,200 6/	-	0	94,400	0	423,800 6/	-	0
Riverton Reclamation Project	14e1-9	73,562	264,000	264,000	0	264,000 6/	-	0	264,000	0	264,000 6/	-	0
Fivemile Creek and Hurley Draw	14e-4	316	1,700	710	990	1,350	640	350	570	1,130	700	130	1,000
Sheep and Muddy Creeks	14e-5	1,484	8,000	3,400	4,600	4,300	900	3,700	2,300	5,700	2,800	500	5,200
Dry Muddy and Cottonwood Creek	14e-6	187	1,000	430	570	1,250	820	0	300	700	300	0	700
North, Middle, & Little Popo Agie	14e1a-1, 2, & 2a	27,213	144,700	119,420	25,280	239,800	120,380	0	103,130	41,570	179,900	76,770	0
Little Wind, Sage, Trout, and Mill Creek	14e1a-3, 4, & 4a	34,704	170,000	115,000	55,000	200,000	85,000	0	100,000	70,000	155,000	55,000	20,000
Beaver Creek	14e1a-5 & 6	942	5,010	3,360	1,630	15,400	12,020	0	2,720	2,290	9,400	6,680	0
Badwater Creek	14e3-1, 2, 3, & 4	3,139	15,400	7,030	8,370	15,980	8,950	0	3,930	11,470	4,660	2,730	9,010
Mainstem Wind River- Riverton to Boysen	-	132	860	860	0	926,000 6/	-	0	860	0	642,400 6/	-	0
Subtotal for Wind River subbasin	-	195,769	868,490	768,800	99,690	-	-	4,050	730,620	137,870	-	-	35,940
Owl, Mud, & Red Canyon Creeks	14e-6a, 8, 8a, & 9	15,678	91,410	32,370	59,040	58,000	25,630	33,410 7/	22,320	69,090	40,000	17,680	51,410 7/
Buffalo, Kirby, & Nowater Creeks	14e7,10a,11,12,12a	384	1,[illegible]0	930	950	1,750	820	130	6[illegible]0	1,200	990	310	890
Cottonwood and Grass Creek	14e-14 & 16	2,918	17,700	9,360	8,340	13,880	4,520	3,820	6,850	10,850	8,660	1,810	9,040
Gooseberry Creek	14e-15	3,818	24,810	9,280	15,530	10,610	1,330	14,200	5,880	18,930	6,700	820	18,110
Fifteen, Fivemile, & Elk Creeks	14e-19, 20, & 21	0	0	0	0	-	-	0	0	0	-	-	0
Nowood River above Tensleep	14e4-1, 2, 3	5,349	29,480	21,440	8,040	69,310	47,870	0	18,950	10,530	52,370	33,420	0
Tensleep and Canyon Creek	14e4-4	1,875	10,340	10,340	0	96,000	-	0	10,340	0	80,000	-	0
Brokenback Creek	14e4-5	619	3,400	3,390	10	16,000	15,610	0	3,290	110	14,000	10,710	0
Buffalo Creek	14e4-5	511	2,820	2,030	790	4,660	2,630	0	1,910	910	4,030	2,120	0
Paintrock & Medicine Lodge Creeks	14e4-6	5,884	32,430	30,230	2,200	121,110	90,880	0	29,520	2,910	104,600	75,080	0
Lower Nowood River	14e4-5, 7	4,929	33,400	33,400	0	271,090 6/	-	0	33,400	0	120,290 6/	-	0
Wood River and Dicks Creek	14e5-1	3,310	10,170	10,170	0	82,800	-	0	10,170	0	58,700	-	0
Greybull River above Meeteetse	14e5-1, 2, 3	5,790	27,500	27,500	0	126,840	-	0	27,100	400	96,840	69,740	0
Sunshine, Stonewall, and Rawhide Creeks	14e5-1 & 3	672	2,080	2,080	0	31,410 6/	-	0	2,080	0	28,080 6/	-	0
Lower Greybull River	14e5-3 & 4	41,616	206,280	173,550	32,730	231,890 6/	58,340	0	128,760	77,520	159,240 6/	30,480	47,040
Dry Creek	14e-5 & 14e5-4	13,868	63,000	57,800	5,200	57,800 6/	0	5,200	54,300	8,700	54,300 6/	0	8,700

Table IV-6--Water supply shortages (Continued)

Name of hydrologic subarea	Watershed numbers	Present area of irrigated land	Irrigation water diversion requirement 1/	50 percent chance: Present water diversions 2/	50 percent chance: Need for stored or transferred water 3/	50 percent chance: Water supply at upper division point	50 percent chance: Storable water within water-short subareas 4/	50 percent chance: Transfer needs	80 percent chance: Present water diversions 2/	80 percent chance: Need for stored or transferred water 3/	80 percent chance: Water supply at upper division point	80 percent chance: Storable water within water-short subareas 4/	80 percent chance: Transfer needs
		---acres---	-acre-feet-	acre-feet					acre-feet				
Upper Shell Creek	14e-22	401	2,210	2,210	0	67,300	-	0	2,210	0	57,200	-	0
Trapper Creek	14e-22	431	2,370	2,370	0	15,300	-	0	2,370	0	13,000	-	0
Horse Creek	14e-23	388	2,130	1,930	200	4,820	2,890	0	1,750	380	4,100	2,350	0
Red Canyon & Beaver Creeks	14e-23	2,033	11,240	6,300	4,940	9,200	[illegible]	2,040	5,900	5,340	7,820	1,920	3,420
Lower Shell Creek	14e-23	7,240	39,890	37,630	2,260	91,050 6/	53,420	0	34,660	5,230	77,040 6/	42,380	0
Bear Creek	14e-24	78	570	570	0	4,100	-	0	570	0	3,600	-	0
Mainstem Bighorn River-Boysen to Kane	-	[illegible]1,579	347,000	347,000	0	925,000 6/	-	0	347,000	0	740,000 6/	-	0
North Fork Shoshone River	14e6a-1, 2, & 2a	1,977	10,900	10,900	0	617,310	-	0	10,900	0	508,810	-	0
South Fork Shoshone River	14e6-1, 2, & 4	23,641	130,310	130,310	0	480,570	-	0	130,250	60	396,100	265,850	0
Sage Creek	14e6-3	403	2,230	1,410	820	3,880 6/	2,470	0	1,110	1,120	2,530 6/	1,420	0
Shoshone River(includes [illegible])	14e6-5,6,7,8, & 8a	122,698	633,480	633,480	0	1,052,000 6/	-	0	633,480	0	857,700 6/	-	0
Crooked Creek	14e-27	1,079	7,160	5,090	2,070	9,910	4,820	0	4,520	2,640	7,710	3,190	0
Porcupine Creek	14e-26	329	1,630	1,630	0	24,740	-	0	1,630	0	19,280	-	0
Subtotal for Bighorn Subbasin	-	[illegible]29,503	1,747,820	1,604,700	143,120	-	-	56,000	1,531,900	215,920	-	-	138,610
Sunlight Basin	14c-1	967	5,320	5,320	0	87,800	-	0	5,320	0	75,200	-	0
Crandall Creek	14c-2	303	1,670	1,670	0	166,600	-	0	1,670	0	142,800	-	0
Pat O'Hara Creek	14c-4	1,595	8,800	7,800	1,000	16,800	9,000	0	7,520	1,280	14,400	6,880	0
Cyclone Bar Area	14c-5	3,679	20,240	20,240	0	73,300	-	0	20,240	0	63,300	-	0
Main Clarks Fork River	14c-3, 4, & 4a	4,575	25,200	25,200	0	356,600 6/	-	0	25,200	0	305,300 6/	-	0
Subtotal for Clarks Fork Subbasin	-	11,119	61,230	60,230	1,000	-	-	0	59,950	1,280	-	-	0
Little Bighorn River	14e7-1	163	810	810	0	104,000	-	0	810	0	86,000	-	0
Pass Creek	14e7-2	2,278	11,080	6,960	4,120	28,000	21,040	0	6,190	4,890	21,500	15,310	0
Subtotal for Little Bighorn Subbasin	-	2,441	11,890	7,770	4,120	132,000	21,040	0	7,000	4,890	107,500	15,310	0
Total for Basin	-	538,832	2,689,430	2,441,500	247,930	-	-	62,850	2,329,470	359,960	-	-	174,550

1/ Based on average annual consumptive uses and estimated existing irrigation project efficiencies.
2/ Diversions shown here do not exceed estimated diversion requirements. Actual diversions may exceed these amounts on streams where water supplies are not limited.
3/ The exercise of water rights may create additional storage needs in some cases.
4/ Figures in this column assume that all undiverted water is storable. Legal and environmental requirements will usually limit storage to smaller amounts.
5/ -means there is no applicable entry.
6/ This estimate includes return flows from upstream irrigated areas.
7/ The accuracy of this estimate is affected by several uncertainties involved in the effects of a recent local reclamation project.

Unherded cattle and sheep remain fairly close to water. Good grazing management requires that a suitable livestock water facility is established on each square mile of rangeland. About two-thirds of the rangeland in the basin is without these needed facilities.

Nonagricultural water shortages

Several of the towns in the basin have facilities and water supplies that are too small to meet peak demands in July and August. The common solution to this problem is to ration water for lawn and garden irrigation during this period.

PHREATOPHYTES

Phreatophytes are plants that generally obtain their water supply from very wet soils. Most phreatophytes have low economic value, and consequently, the water they use and return to the atmosphere may be defined as consumptive waste.

There are approximately 310 square miles of phreatophytes within the basin. Table IV-7 lists phreatophyte areas in the major subbasins in Wyoming. (Table II-11 listed phreatophyte areas within watersheds.) The predominant types of phreatophytes are sedges, rushes, greasewood, willows, and cottonwoods. Sedges, rushes, and willows occur mostly where they have invaded wet hay meadows, ditches, and streambanks. Cottonwoods extend along the full length of most of the streams in the basin. They generally grow in narrow banks, but they do cover broad areas between large stream meanders and stream junctions. Phreatophytes in the basin use an estimated 346,500 acre-feet of water per year.

There are no notable programs for control of phreatophytes in the basin. Some projects have been proposed, such as in the Bureau of Reclamation's Garland Division and in the lower Greybull River area. These projects involve the drainage of wet and phyreatophyte infested lands with their subsequent return to agricultural productivity. Most phreatophyte control has been at the local level, associated with canal and irrigation system renovation and on-farm land clearing and leveling.

The Wyoming Game and Fish Commission has developed two areas of heavy phreatophyte concentration as wildlife management units. Cottonwood trees provide very important deer habitat. Phreatophyte areas also provide habitat for antelope, waterfowl, small game, upland game, and livestock. Cottonwoods and willows along streams provide shade and cover for fish and other aquatic species and attractive recreation areas for man.

Table IV-7--Phreatophyte areas

Subbasin	Area
	----square miles----
Wind River	118.8
Bighorn	186.5
Clarks Fork	4.7
Little Bighorn	0
TOTAL	310.0

POLLUTION

Pollution and water quality are interrelated, and high water quality usually indicates a lack of pollution. However, if flow volumes in the receiving stream are high, and if the pollutant discharge is biodegradable and is not great, it is possible that the stream system can accept the pollutant discharge without a significant drop in water quality.

Municipal and industrial waste water sources in the basin tend to be unique in character because of the paucity of manufacturing processes in the basin. As a result, the wastes are usually domestic in character, and lend themselves to treatment, stabilization, or full retention. In only one case is there a greater than acceptable biological burden, and this discharge is presently under a plan of implementation for full abatement. Most other municipal, industrial, and commercial discharges are assimilated by the receiving stream with only negligible water quality effects. The significant deviation from this situation is the widespread existence of oil and gas wells. These wells often produce significant amounts of heavily-mineralized and oil-laden water. The industrial practice is to provide a primary oil separation treatment to these waters before releasing this water to the environment. These wells are located in a generally arid basin and contribute water, albeit mineralized, that is used for stock water and irrigation. When not used in this manner, the discharge usually evaporates or seeps into the soil before reaching a live stream. In those cases where discharges have adversely affected downstream water uses, abatement measures have been initiated by the Wyoming Game and Fish Commission, the State Health Department, and other agencies.

Sediment pollution has been discussed under sediment damages earlier in this chapter.

Pollution from recreational facilities is generally low because of proper use, operation, and maintenance of private, state, and federal facilities. However, improper, clandestine, uncontrolled access, and improper vehicular or recreational use of such areas can generate serious biological, mineral, and sediment burdens to the watershed. Off-road vehicles can be especially damaging to the land and can cause serious erosion problems which add a mineral and sediment burden to the basin's water.

Some developed recreation sites on the national forests are being damaged by over-use. The campgrounds and picnic areas are used heavily during the summer months. Sites on the Wapiti Ranger District suffer from spillover use from Yellowstone National Park. Soil compaction, reduction of vegetative cover, accelerated erosion, and increased sediment production are occurring. Water pollution by garbage, silt, organic wastes, and chemicals such as oil and gasoline is becoming more serious.

Wilderness areas suffer damage from riding stock and trail riders. Alpine tundra, meadows, and bogs are particularly susceptible. Increased human and animal use of some wilderness areas is causing health and sanitation problems.

Agricultural production contributes to water pollution through irrigation return flows, cropland erosion, feedlot runoff, and improper grazing practices.

RELATIONSHIP OF WATER PROBLEMS TO IMPAIRMENT OF NATURAL BEAUTY

Some of the most scenic areas in the west are found in this river basin. High, rugged mountains with their glaciers, evergreen forests, grass-covered hills, and clear mountain streams are present. However, some tributary streams that once were clear are now clouded by soil losses from accelerated erosion. Some large reservoirs contain suspended solids and other pollutants during spring runoff periods which detract from their attractiveness for boating, fishing, swimming, and other similar pursuits.

Some tributary streams such as Badwater Creek which once flowed through grassy meadows are now gullied channels. Periodic flooding on major streams causes channel changes, bank erosion, and channel scouring.

OTHER FOREST-RELATED PROBLEMS

Insect and disease damages are high on most forest types. It is estimated that up to 50 percent of the gross annual timber growth may be lost to insects and diseases. Mountain pine beetle, douglas-fir beetle,

and spruce budworm are endemic insects in nearly all stands. Major diseases causing loss are dwarf mistletoe, commandra rust, butt rot, and heart rot.

Range and forest fires occur often and there is a cyclic pattern in the occurrence of large fires. About 150 fires burn over 8,900 acres in the basin each year. The majority of the fires are small and result in relatively minor damages. Large, disastrous fires occur periodically and cause significant economic and environmental damage.

Some major problems which could contribute to disastrous fires are (1) a heavy accumulation of logging debris and slash on some areas, (2) extensive stands of overmature timber, and (3) large areas of insect damaged timber. Other factors contributing to fire problems include heavy buildup of fuel on areas long protected from fire; increased use by hunters, recreationists, and other users of forest resources; and a lack of organized fire protection for private land in some counties.

Timber losses due to insects, diseases, and animal and mechanical damage are significant on large areas of overmature forest. In addition, overstory suppression causes reduced growth rates on thousands of acres of seedlings and saplings.

Another major problem is the lack of adequate regeneration as a result of damage from livestock, wildlife damage, insufficient summer moisture, the large size of some nonstocked areas, and erosion of the thin young soil. The Paint Creek and Pat O'Hara Creek watershed areas have particularly severe problems.

Overgrazing, poor stocking of vegetation, and concentrations of noxious and poisonous plants damage rangelands and prevent full production and use of grazing resources on national forest land.

Full use of forest recreation resources is inhibited by the lack of developed facilities and sites, inadequate road networks, insufficient trails development, and uneven geographic distribution of lakes, reservoirs, and other water developments.

FISH AND WILDLIFE HABITAT PROBLEMS

Historically, loss and degradation of habitat is the primary problem related to fish and wildlife. This loss and degradation has been largely compensated for by aquisition and management of key winter ranges for big game, hunting and fishing easements on private lands, and construction and protection of nesting areas for waterfowl.

Big game

Winter habitat is the main limiting factor for big game. Decreases in winter habitat have resulted from development of minerals, highways,

agriculture, recreation, and other human activities. Specific problem areas are described below.

a. Open pit mining and increased mineral exploration has decreased some winter habitat in the Gas Hills Mining District southeast of Lander.

b. Lack of watering facilities in the "badlands" in the central portion of the Bighorn Basin limits wildlife use of these areas.

c. Fencing throughout the basin somewhat restricts migration and distribution of big game. Overgrazing by livestock in some areas limits food for elk and deer both in summer and winter.

d. Artificial reduction of sagebrush and willow in large blocks has reduced some winter habitat for moose, deer, sage grouse, and antelope. The effects of big sagebrush management in any location should be carefully evaluated before applied.

e. Moose habitat in the basin is very limited and should be carefully evaluated before developing any large reservoirs.

f. Increasing numbers of people using motorized vehicles during all seasons of the year have increased pressure on big game in some critical areas such as in the Big Horn Mountains near Shell Creek and in the Wind River Mountains near Union Pass.

Upland and small game

Intensive agriculture has affected upland and small game more than any other species of wildlife. A change in agricultural practices can benefit some species while adversely affecting others. For example, cropped areas improve habitat for pheasant, quail, ducks, and rabbits, but drastically decrease habitat for sage grouse.

However, some agricultural practices decrease habitat for all wildlife on agricultural lands. Lining ditches with concrete, clean farming, the use of pesticides, and grazing and clearing windbreaks are examples of such practices.

Sage grouse habitat is reduced because of sagebrush control and mining operations. Lack of watering facilities also affects upland and small game distribution.

Waterfowl

Waterfowl habitat is limited in the basin by lack of nesting and feeding areas.

Furbearers

Furbearers generally require heavy cover along streams. Much of this habitat has been removed through agricultural practices, road building, and other activities.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

Water and related land resources of the basin need to be managed and developed to minimize present problems and alleviate present and future needs. Demands on these resources will increase due to greater use by both residents and nonresidents. Practices and measures needed to protect and improve the management and use of these resources are discussed in this chapter. As land and water are used more intensively, all landowners should be concerned that existing abuses are stopped and that new uses are properly planned, carefully applied, and wisely managed.

NEEDS FOR WATERSHED PROTECTION AND MANAGEMENT

General

There are about 13,179,000 acres of land and water in the Wyoming portion of this river basin. About 5,115,000 acres of land are owned by the state and by private owners. Table V-1 lists estimated needs for conservation practices for state and private lands as presently used. If some irrigable lands are developed into irrigated lands, they will need all of the practices listed for irrigated lands.

The first line in table V-1 includes estimates of areas where the present level of conservation treatment is adequate. This means that needed structural measures are installed, management and cultural practices are implemented, and water is efficiently used. However, there is still a need to continue the existing level of management and to maintain existing systems or replace them as they wear out.

Improved treatment needed on irrigated croplands

About 80 percent of the irrigated land in the basin needs some kind of improvement of structural systems, cultural management, 1/ water management, or a combination of improvements to achieve proper conservation use. The principal need is for improved irrigation and drainage systems. These include land leveling, channel lining, control structures, pipelines, sprinkler systems, tailwater recovery systems, and drainage systems. Needs for drainage are discussed in more detail later in this chapter.

Where system improvement is needed, proper management of water is difficult, if not impossible. It is also true that structural systems must be properly managed in coordination with other practices to achieve their full potential. About 40 percent (217,240 acres) of the irrigated land needs the complete treatment of improved cultural management, water management, and irrigation systems.

1/ Cultural management includes, but is not limited to, such practices as rotation cropping, minimum tillage, stubble mulching, contour furrowing, and rotation grazing.

Table V-1--Conservation treatment needs on state and private lands with present land use

Kinds of conservation treatment needed	Irrigated cropland	Other cropland	Pasture and rangeland 2/	Non-federal forest	Other agricultural	Total
	acres					
Present treatment adequate or treatment infeasible	107,820	1,233	1,436,350	251,690	43,360	1,840,453
Improved treatment needed on irrigated land:						
Irrigation and/or drainage systems	217,240					217,240
Water and cultural management	159,940					159,940
Cultural management only	53,830					53,830
Improved treatment needed on non-irrigated cropland:						
Erosion control		2,283				2,283
Soil maintenance and improvement		554				554
Improved treatment needed on range and dry pasture:						
Proper grazing use and planned grazing systems only			2,156,810			2,156,810
Accelerated range improvement:						
Brush and weed control			555,600			555,600
Reseeding			7,400			7,400
Range renovation			13,890			13,890
Improved treatment needed on forested land:						
Disease and weed control				80,970		80,970
Reduction of grazing				7,640		7,640
Revegetation needed on other agricultural lands					18,600	18,600
Total	538,830	4,070	4,170,050	340,300	61,960	5,115,210 3/

1/ Compiled from "Wyoming Conservation Needs Inventory," 1970, Soil Conservation Service and U.S. Forest Service inventories.

2/ All irrigated pasture is included in cropland.

3/ Does not include 144,850 acres of water and state and private lands in non-agricultural uses.

Among the important conservation needs in the basin are improved irrigation water delivery structures, tailwater recovery structures, and improved water management on the fields.

PLATE 20

Rhizomatous wheatgrasses are native to rangelands in the basin. Good healthy grasses are food for livestock and wildlife and cover for birds and other small animals. Grasses improve soil structure, prevent soil erosion, and increase soil moisture by reducing losses of snow and rainfall.

About 80 percent of the private and state land in the basin is rangeland. The primary range conservation need is improved grazing systems and management.

PLATE 21

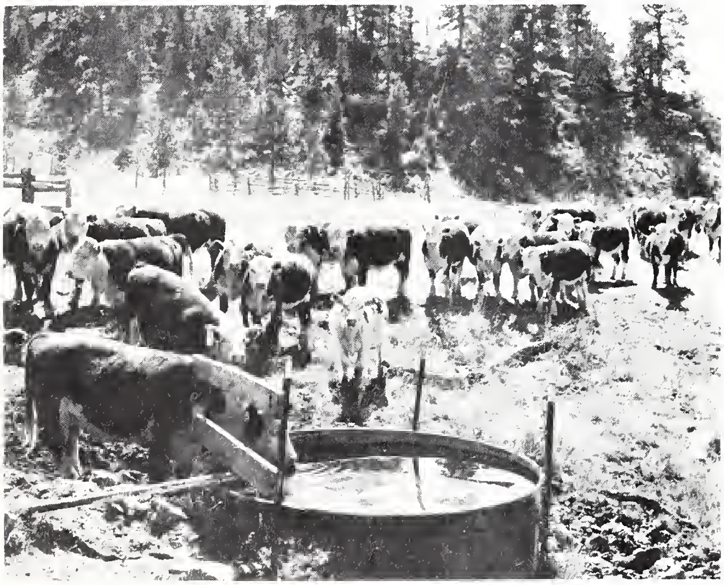
About 14 percent of the rangeland needs brush management and weed control.

Grass for livestock is not enough. Wildlife habitat needs must be properly considered.

A well-balanced plant community is needed to provide for a variety of life.

PLATE 22

There wasn't enough water to provide a second irrigation. Both supplemental water supplies and improved irrigation efficiencies are needed.



Only about one-third of the livestock water supplies needed to improve range use have been developed.

PLATE 23

On about 30 percent of the irrigated cropland an acceptable water control system exists, but both water and cultural management need to be improved. On about 10 percent of the irrigated land a good system exists, good water management is practiced, but cultural management still needs to be improved.

Improved treatment needed on nonirrigated croplands

There are only about 4,070 acres of nonirrigated cropland in this basin in Wyoming, and this is all in the Little Bighorn portion of Sheridan County. About 60 percent of this area needs some conservation treatment to improve the soil and prevent erosion.

Improved treatment needed on rangeland and dry pasture

About 73 percent of the river basin is rangeland and dry pasture. About 58 percent of this is in federal land. Federal resource management programs are directed at maintaining and improving vegetative cover on these lands and are discussed in other portions of the report. The remaining 42 percent is state and privately owned and represents about 81 percent of all state and private lands. About 66 percent of state and private rangeland needs improved conservation treatment.

Erosion is the most significant problem on private and state rangelands. If these lands are properly vegetated, there will be little need for structural works for erosion control and the overall productivity will increase. Vegetation can generally be improved in a reasonable time through good grazing management practices alone. Increased use of these practices is the principal conservation need on range and dry pasturelands. Some of the needed practices are rotation grazing, rotation deferred grazing, stockwater developments, and fencing. About 52 percent of non-federal range and dry pasturelands need these practices.

When the practices mentioned above cannot improve the vegetative cover effectively or in reasonable time, accelerated chemical or mechanical range improvement practices are needed. These practices include brush and weed control, reseeding, and range renovation. About 14 percent of the state and private range and dry pasturelands in the basin need accelerated chemical or mechanical range improvement practices.

Nonfederal forest lands

About 3 percent of the basin is nonfederal forest land. Approximately 25 percent of this land needs improved conservation treatment. Federal and nonfederal forest land development and improvement needs are discussed together, later in this chapter.

Other private and state land

About 30 percent of the small area of land in miscellaneous uses needs revegetation treatment.

FLOOD PROTECTION AND SEDIMENT CONTROL NEEDS

Protection from damaging floodwaters is needed on most of the principal tributaries of the Bighorn River and on isolated tributaries of the Wind River. Floodwaters and sediment deposits along those streams have caused damage to homes, crops, livestock, agricultural improvements, and wildlife. Where more frequent flooding has occurred, lands have been left idle or have been abandoned. The following specific areas have been identified as needing protection:

a. Crow Creek: Protection is needed along the lower reaches of the creek to protect irrigation diversion structures, croplands, farm buildings, livestock, and wildlife.

b. Beaver Creek: Damages along the creeks are relatively low, but cost of protection would also be relatively low. Protection is needed for irrigation structures and croplands.

c. Badwater Creek: Protection is needed in Upper Badwater Creek to reduce streambank erosion and flooding of croplands. Damages are relatively low, but the cost of providing protection in a multi-purpose structure would also be relatively inexpensive.

d. Little Popo Agie: Protection is needed from above the confluence of this river and Twin Creek down to the Popo Agie River. The most urgent protection is needed in Lyons Valley where floodwaters have damaged crops, farm buildings, irrigation structures, livestock, and have seriously damaged pheasant habitat and in the town of Hudson where floods have damaged homes, commercial property, and roads.

e. Nowood River: Protection is needed for the agricultural lands from Big Trails to Manderson and in the town of Manderson. Prolonged flooding conditions have damaged crops, irrigation structures, roads, bridges, wildlife habitat, and caused severe streambank erosion. Structural measures are needed in the town of Manderson to protect homes, the school, commercial properties, and streets. Structural measures are also needed along much of the Nowood River channel to protect the banks from erosion.

f. Greybull River: Structural and land treatment measures are needed to protect agricultural lands, irrigation structures, wildlife habitat, and roads and bridges along the river from above Meeteetse to the Bighorn River. Frequent channel changes during high flows have destroyed croplands, wildlife habitat, and left irrigation diversion structures inoperable.

g. Shell Creek: Structural and land treatment measures are needed to reduce floodwater damages to agricultural properties and reduce streambank erosion. Floodwater flows have damaged croplands, wildlife habitat, and aesthetic qualities of one of the most scenic creeks in the basin.

h. Shoshone River: Land treatment and structural measures are needed to reduce floodwater and streambank erosion damages along the South Fork above Buffalo Bill Reservoir and on tributaries of the North Fork above the reservoir. Floodwaters on the South Fork have damaged crops, farm buildings, irrigation structures, wildlife habitat, and caused severe streambank erosion. Land treatment measures are needed in the forested and rangeland areas to reduce runoff and along the streams to reduce bank erosion. Floodwater damages on North Fork occur primarily along the tributaries and damage crops, homes, commercial properties, and roads. The unstable nature of the channels and topography of the watersheds would reduce the effectiveness of structural programs. Land treatment measures in the upper watersheds would thus be the most efficient means of protecting the lands below. Floods along the Lower Shoshone cause frequent damage to agricultural properties, wildlife habitat, and cause serious streambank erosion. Structural and land treatment measures are needed to reduce flows and stabilize the channel.

Damages from floodwater also occur in other smaller areas in the basin and may require land treatment or small structural measures to provide needed protection.

GULLY AND STREAMBANK STABILIZATION NEEDS

The 1970 Conservation Needs Inventory lists approximately 70,000 acres of private range and croplands in the basin as having a serious erosion problem. These unstable areas need structural control practices to protect the land during storms, control the runoff, and dispose of irrigation waste flows at nonerosive velocities in addition to the watershed protection and management needs discussed earlier in this chapter. Gully plugs, terraces, floodwater diversions, chiseling and subsoiling, critical area planting, and mulching are examples of practices needed on these lands.

Much of the 70,000 acres are affected by unstable channels in the basin. About 1,200 streambank miles are presently unstable and erode more each year during periods of high flow. About half this mileage is on small tributaries of the larger streams. Many of these are intermittent streams. Practices needed on the tributaries include grade stabilization structures, debris basins, channel stabilization, streambank protection, clearing and snagging, and grassed waterways. The critical areas needing these practices are portions of upper Wind River, Popo Agie tributaries, Beaver Creek, Fivemile Creek, Bridger Creek, upper Nowood River, upper Greybull tributaries, tributaries of the Shoshone River, and Sunlight Creek.

The remaining 600 miles of eroding streambank are along larger streams. Practices needed to reduce this erosion include streambank protection, channel

stabilization, clearing and snagging, diversion dams, flood and sediment retarding dams, dikes, and gradient stabilization structures for irrigation return flows. Critical areas needing these practices are found on the lower portions of Little Wind River, Popo Agie River, Badwater Creek, Muskrat Creek, Nowood River, Greybull River, Sage Creek, Nowater Creek, Cottonwood Creek, Gooseberry Creek, Shell Creek, Kirby Creek, Pat O'Hara, and Paint Creek.

If applied, conservation practices shown in table V-1 will also help reduce gully and streambank erosion by reducing surface runoff rates, thus reducing erosive energy in the basin's streams.

Artificial as well as natural channels need to be stabilized. One of the most critical of these is the Enterprise Ditch near Beason Creek near Lander.

DRAINAGE IMPROVEMENT NEEDS

There are approximately 98,000 acres of wet and saline cropland in the basin. Subsurface drainage and improvement of conveyance systems and on-farm irrigation water management is needed to improve conditions on this land. Canal and ditch lining is needed to prevent recharge from seepage, and improved irrigation water management is needed to maintain a salt balance and improve crop production.

Surface drains are needed in some of the wet mountain meadow areas in the high, irrigated valleys along the upper reaches of the Wind-Bighorn-Clarks Fork Rivers and their tributaries. The soils in these areas are generally shallow and non-saline, the fields are small and uneven, and the wet areas are usually restricted to small, extremely boggy spots.

The most critical areas in need of drainage are the Midvale-Pavillion, north Worland, Burlington-Otto, Deaver-Frannie, and north Powell areas where deep, fine-textured, wet and saline soils occur. Other important areas are located along the Wind River, Little Wind River, and Popo Agie Rivers, Owl Creek, Nowood River, the lower South Fork of Shoshone River, and along the Bighorn River near Kane. Drainage is needed in the remainder of the irrigated areas in the basin where more shallow and more permeable soils transmit irrigation percolation losses to adjacent lower lands. Additional drainage will also be needed as new land is brought under irrigation.

Many miles of open, subsurface drains have been installed in the past. Most of these drains need rehabilitation or replacement by tile line systems.

NEEDS FOR IRRIGATION WATER

Agriculture and businesses dependent on agriculture account for most of the economic activity in the river basin. This situation is expected to exist in the future. Underemployment, low per capita income,

and high outmigration rates are economic and social problems discussed earlier in this report. There is a need to reduce these problems in the region. This can be done by increasing and stabilizing farm incomes through increased agricultural production.

Any increase in crop production also increases the consumptive use of water by those crops. Where the water presently available to a crop is less than its potential consumptive use, an increase of water supply alone will increase production. Some of this water can be applied without increasing irrigation water diversions. This is called increased efficiency. Improved irrigation systems and improved management of water will reduce tailwater, percolation, and evaporation as well as improve the uniformity of water distribution on the field. This is discussed in more detail earlier in this chapter. It is painful to learn, however, that this approach seems to have the least effect on production where water supplies are shortest and where present field irrigation efficiencies appear to be the lowest. In much of the river basin, especially in its central portion along smaller streams, improved field efficiencies cannot provide for a significant increase in crop production. These areas need additional late season water supplies from storage reservoirs, wells, or intra-basin transfers of water if production is to be increased. Only when these supplemental supplies are provided will the benefits exceed the costs of improved water management.

There are about 538,800 acres presently irrigated. About 182,000 acres are in water-short areas where about 359,960 acre-feet of supplemental water is needed per year in dry years. See table IV-6.

As stated in chapter 3, irrigated land is expected to increase from 538,800 acres to 600,100 acres by 2020. This is an increase of 61,300 acres. These new irrigated lands will need about 130,000 acre-feet of water per year for consumptive irrigation requirements. If this water is used at 50 percent efficiency, the diversion requirement will be about 260,000 acre-feet per year.

FOREST LAND DEVELOPMENT NEEDS

Forest land development needs are listed in table V-2 for all forested land in the basin. The state and private forested land treatment needs shown in table V-1 are also included in this table.

Projections of economic activity for the nation, region, and basin show a need to increase timber production. In order to meet expected demands, the supply of timber available for harvesting needs to be increased 12 percent in 1980, 31 percent in 2000, and 39 percent in 2020.

Planting or seeding is needed to reforest or regenerate 9,600 acres of forest land. This will reduce accelerated erosion and sediment production, improve hydrologic conditions, and contribute to long-range satisfaction of timber needs.

Table V-2--Forest and rangeland development needs by ownership, Wind-Bighorn-Clarks Fork River Basin, Wyoming

Development need	Unit	Amount and ownership				
		National Forest	Public domain	Wind River Indian Reservation	State & private	Total 1/
Range revegetation Plant control, type conversion	acres	36,600	37,300 2/	253,000	NA 3/	326,900
Range distribution trails	miles	190	350	0	NA	540
Range fences	miles	625	1,000	0	NA	1,625
Range water developments	each	325	2,010	80	NA	2,415
Planting or seeding	acres	6,400	2,000	600	600	9,600
Timber management:						
Insect control	acres	51,300	5,000	0	30,000	86,300
Disease control	acres	140,000	0	12,600	0	152,600
Release, harvest, thin, and weed	acres	74,500	0	10,000	108,000	192,500
Fishing stream improvement	miles	820	NA	NA	NA	NA
Fishing lake improvement	acres	4,750	"	"	"	"
Wildlife habitat management	acres	11,700	"	"	"	"
Fence Key Wildlife Areas	miles	60	"	"	"	"
Trail construction and improvement	miles	1,700	"	"	"	"
Road construction and improvement	miles	1,720	"	"	"	"
Roadside observation sites	each	40	"	"	"	"
Erosion control:						
Gullies	miles	125	"	"	"	"
Sheet erosion	acres	4,100	"	"	"	"
Abandoned roads and trails	miles	260	"	"	"	"
Streambank stabilization	miles	30	"	"	"	"
Mining control and restoration	acres	25	"	"	"	"
Snowpack management, Alpine	miles	65	"	"	"	"
Recreation site improvement	acres	1,150	"	"	"	"

1/ More than one practice may be needed on a given acre of land.
2/ Treatment planned - total needs are not known.
3/ NA means data are not available.

About 192,500 acres of over-mature forest stands need to be harvested and regenerated or given salvage and sanitation cuts. This will solve problems of decadence and excessive losses from insects and diseases on these areas. Timber supplies can be significantly increased, and grazing and wildlife resources can be improved.

Thinning, weeding, release cutting, pruning, and other cultural treatment is needed to reduce fuel accumulations, improve growth, and combat insects and diseases on 238,900 acres.

Range seeding, proper herding and distribution, control of noxious and poisonous plants, stockwater developments, and range fencing are needed to improve forage and meet demands for forest land grazing. Type conversion, plant control, and revegetation is needed on about 326,900 acres. About 1,625 miles of fencing to control grazing, 2,415 stock reservoirs, and 540 miles of stock distribution trails are needed.

There is a need for restoration and habitat improvement on 820 miles of streams and 4,700 acres of lakes on national forest land. About 30 miles of streams need treatment to stabilize banks and reduce sediment loads.

Management needs of terrestrial wildlife habitat include wildlife openings and food patches, thinning of dense, stagnated timber stands, openings and trailways in timber, and cover strips in cleared forest areas. On national forest land about 11,700 acres of wildlife habitat restoration and improvement and 60 miles of fencing are needed. Special management and protection is needed to sustain several rare and endangered species.

Fire prevention and control measures are needed to reduce the number, size, and intensity of range and forest fires. Some of these needs are reduction of fuel and logging debris, salvage of insect damaged stands, improved fire detection, additional fire weather stations, intensification of aerial fire control, increased use of prescribed burning to reduce fuels and other hazards, hazard reduction along roads and trails, expansion of state protection to private lands not now covered, and improved coordination between suppression agencies.

Roads, trails, mines and excavations, overgrazed areas, and areas damaged by off-road travel need erosion control measures, revegetation, and hydrologic improvement. On national forest land sheet erosion control is needed on 4,100 acres, 125 miles of gullies need control, 260 miles of eroding roads and trails need rehabilitation, and 25 acres of eroding mine areas need treatment.

There is a need for additional development of recreation sites to alleviate seasonal over-use and deterioration of sites and to satisfy projected recreation demands.

An adequate system of roads and trails is needed to develop, manage, and protect forest resources. Construction and reconstruction is needed on about 1,720 miles of forest roads. Included is a network of low-speed, high standards scenic roads with more than 40 scenic observation sites. About 1,700 miles of recreation trails for backpack hiking, horseback riding, trail bike and snowmobile use, and walking for pleasure are needed.

RURAL, DOMESTIC, AND LIVESTOCK WATER SUPPLY NEEDS

The primary need for new water supplies is associated with proper range management. As a rule of thumb there should be some watering facility for livestock in each square mile of rangeland to promote even distribution of grazing pressure. Surface water in streams, ponds, and springs is not distributed well enough to provide the needed supply. More wells, spring developments, and ponds need to be developed. Only about one-third of the needed watering places have been developed on rangelands in the basin.

Ground-water wells and springs are principal sources for farmsteads and small communities. Surface streams and ponds are also important supplies. In some areas both surface and ground-water supplies are highly mineralized. In other areas surface supplies are very limited, and ground-water aquifers lie deep underground. In these areas it is necessary to transport water for domestic and livestock purposes.

Usually, more of the livestock water supply is evaporated than is used by the livestock. Estimated average water needs for evaporation and consumption by livestock are about 40 gallons per day per animal unit. Domestic needs can vary from 5 to 150 gallons per day per person depending on the manner and number of uses involved. An estimate of average rural domestic use per person might be 60 gallons per day.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY NEEDS

Some towns have a need to enlarge and improve their water supply systems to replace old systems or to handle population expansion. Present industries have developed suitable supplies, but new industries need to consider water supply problems in their chosen potential sites.

RECREATION NEEDS

Recreation is an important use of water and related land resources in the basin and the surrounding area. Yellowstone and Grand Teton National Parks, Big Horn Canyon National Recreation Area, and several wilderness and primitive areas are located in or adjacent to the basin. Many tourists and recreationists travel to or through the basin while enroute to these well-known attractions. A major part of the recreation activity occurs on public lands.

There are four state parks covering an area of 55,500 acres of land and water. Hot Springs State Park at Thermopolis contains one of the world's largest mineral springs and one of the few remaining buffalo herds. Sinks Canyon State Park is located in a very scenic area on the Middle Popo Agie River. Boysen and Buffalo Bill State Parks surround large reservoirs, each containing several thousand surface acres. Dude ranches, resorts, historic places, and municipal parks also provide recreation opportunities.

Recreation needs in the basin are a function of both local and national forces. However, the latter will become increasingly more important in the future. Along with increases in population, vacation and leisure time, and per capita income, there will be associated increases in recreational pursuits. The Wind-Bighorn-Clarks Fork Basin with its large areas of public lands, will have to absorb some of this pressure.

Estimated levels of recreation activity for the basin are shown in table V-3. Total use is projected to increase from 4,870,400 visitor days in 1970 to 11,420,400 visitor days in 2020, an increase of 135 percent. This change will be a function of increases in both resident and nonresident populations as well as changes in participation rates for each. The projections of use may be low because of population increases associated with coal mining east of the basin in Wyoming and Montana.

In this report, all levels of recreation activity are expressed in visitor-days. One visitor-day equals 12 hours of recreation activity. For example, one visitor-day of picnicking represents six persons having one 2-hour picnic or one person having six 2-hour picnics. One person camping for a 24-hour period would account for two visitor-days. Each visitor-day may represent more than one recreational experience. More than half of the total annual use occurs during peak periods associated with weekends and holidays.

The numbers listed in table V-3 are for the basin as a whole. They indicate a surplus of facilities over expected use for all the activities listed except camping. However, the quality of recreational experiences is not expressed by these numbers. For example, the total usable water surface in the basin is more than enough for the number of boats used in the basin. The capacity of existing docking and ramp facilities well exceeds the reported and expected use. Nevertheless, a 1967 boating survey in Wyoming revealed that both resident and nonresident boaters felt that more and improved ramp facilities were needed. There are indications that locally available water surfaces suitable for water skiing are in short supply.

Camping facilities in the basin are not now adequate for peak period demands although some campgrounds are not completely filled even during peak periods. The need is for additional facilities in high use locations. If the present supply of individual camping spaces is compared

Table V-3--Present and projected use and supply of recreation activities

Activity	Current	1985	2000	2020
	------------thousand visitor days------------			
Boating				
Use	70.0	98.0	118.0	148.0
Supply	206.0	206.0	206.0	206.0
Outdoor swimming				
Use	77.7	113.5	135.0	172.7
Supply	135.0	135.0	135.0	135.0
Camping				
Use	1,797.0	2,424.0	2,932.2	3,741.1
Supply	3,338.0	3,338.0	3,338.0	3,338.0
Picnicking				
Use	108.7	134.5	161.2	202.3
Supply	218.1	218.1	218.1	218.1
Sightseeing				
Use	2,481.5	3,822.1	4,932.0	6,348.8
Supply	34,433.0	34,433.0	34,433.0	34,433.0
Snow skiing				
Use	52.7	105.7	125.9	155.9
Supply	136.0	136.0	136.0	136.0
Hiking				
Use	282.8	425.0	514.0	651.0
Supply				
Total use	4,870.4	7,122.9	8,918.3	11,420.4

to the estimated peak period use, the additional camping spaces needed are as follows:

Time	Additional camp spaces needed
Present	210
1985	700
2000	1,040
2020	1,780

However, providing adequate camping spaces for the estimated peak period demand with conventional facilities is likely to be economically inefficient because of the cost of managing, policing, and maintaining them during slack periods of low revenue. This is probably the principal reason that some existing facilities are less than adequate and a few are overtaxed to the point of damage. The disparity between use and supply can be reduced by modifying either use or supply. New approaches are needed to redistribute the timing and nature of recreation uses and to provide adequate, attractive facilities at the least cost with minimum adverse effects on the environment. One example might be to provide more special use facilities and reduce the dual use of camping facilities. Changes are needed for both public and private facilities.

Snowmobiling is becoming a very popular outdoor recreation activity in the basin. In 1972, there were 1,930 snowmobiles registered in the study area as compared to 7,537 for the entire state. However, it was estimated that 12,000 to 15,000 snowmobiles are owned by Wyoming residents. No attempt was made to measure the total visitor-days of use associated with this activity.

As the use and development of recreation areas increase, there will be a greater need to control the location and distribution of facilities. This may require city and county zoning laws, additional information concerning use-density relationships, and improved design and maintenance of recreation facilities.

FISH AND WILDLIFE HABITAT NEEDS

There are 4,254 miles of stream and 61,340 surface acres of natural lakes, reservoirs, and farm ponds that provide sport fishing opportunities in the basin. Annual fisherman-days of use and capacity in 1971 are shown in table V-4.

The greatest fishing pressure in terms of fisherman-days occurs on lowland lakes and reservoirs. Most of this use is on large reservoirs including Boysen Reservoir, Buffalo Bill Reservoir, Bighorn Lake (Yellowtail Reservoir), and Ocean Lake. Part of the reason for this is that these lakes are open for some kind of fishing during the whole year.

Alpine lakes and reservoirs and streams also provide many fisherman-days of use. The nonresident and tourist anglers (5-day license holders) tend to fish in the streams more than lakes and reservoirs, while the opposite is true with many resident fishermen. Twenty-one percent of the ice fishing in Wyoming takes place in the Wind River portion of the basin.

Table V-4--Estimated fishing pressure and capacity of streams, lakes, reservoirs, and farm ponds, 1971

Item	Amount		Use	Capacity
	Area	Length		
	--acres-	--miles--	--annual fisherman-days--	
Streams		4,254	26,655	80,757
Alpine lakes and reservoirs	9,683		20,384	89,604
Lowland lakes and reservoirs	51,526		81,289	313,548
Farm ponds	132		2,870	2,870
Total	61,340	4,254	130,198	486,779

Source: Wyoming Game and Fish Commission

Farm ponds currently provide only a small part of the fishing resource, and they are generally used to their practical maximum capacity. Streams, lowland lakes and reservoirs, and alpine lakes and reservoirs could support 3.0, 3.8, and 4.4 times the present fishing pressure respectively without changing the existing management policies. These capacity levels cannot be maintained if there is a degradation in quantity and quality of the fisheries.

The number of hunters, hunter-days (including successful and unsuccessful hunters) and estimated harvest in 1969 for the basin are shown in table V-5. Participation in hunting is influenced in part by licensing requirements. For some species, licenses are issued on a quota basis. The nonresident hunting and fishing license entitles the holder to take an antlered elk and to fish. For most of the sportsmen in this category, elk hunting is the primary intent, and fishing rights are generally incidental or of secondary importance.

The demand for hunting opportunities for both residents and nonresidents is expected to increase substantially. Population increases and changes in socio-economic characteristics will greatly influence the amount of hunting opportunities desired.

Table V-5--Hunters, hunter-days, and harvest of game, 1969

Type of game	Hunters	Hunter-days	Harvest
	---number---		
Big game:			
Deer	23,210	72,898	15,991
Elk	12,969	50,347	4,623
Moose	81	261	70
Black bear	860	4,804	103
Antelope	3,146	6,288	3,094
Bighorn sheep	161	1,107	47
Total	40,427	135,705	23,928
Upland and small game: 1/			
Pheasant	7,480	25,519	25,767
Chukar partridge	4,071	14,376	14,052
Hungarian partridge	1,677	6,378	3,762
Sage grouse	2,976	8,170	13,095
Blue and ruffed grouse	209	523	410
Cottontail rabbit	4,356	22,745	41,147
Total	20,769	77,711	98,233

1/ Bobwhite quail are also hunted, but information is not available.

Source: Wyoming Game and Fish Commission

The capacity to increase the supply of game species is dependent upon the quantity and quality of habitat available. Acquisition and management of additional habitat areas as well as better protection of existing habitat will be needed in the preservation of present populations and provision for expanding the future carrying capacity.

NEEDS FOR WATER QUALITY CONTROL

At 620 to 695 mg/l the dissolved solids content of the water leaving Wyoming in the Bighorn River is approaching the recommended upper limit of basic domestic and livestock use. There is a need to institute programs which will prevent any further degradation of water quality and then enhance water quality where this is feasible as by treating feedlot wastes, reducing erosion, and other actions.

RURAL AREA ELECTRIC POWER NEEDS

The directory of the Tri-State Generation and Transmission Association

lists six rural electric cooperatives serving rural areas in the Wyoming portion of this river basin. In 1970 they supplied about 380,000,000 kilowatt-hours (KWH) of electric power. The Power Requirements Office of the Rural Electrification Administration estimates that power needs of these six rural electric cooperatives will expand as follows:

Forecast year	1980	2000	2020
Kilowatt-hours needed	546,000,000	1,500,000,000	3,100,000,000

These are forecasts based on a continuation of past trends and may be significantly over or under estimated. It is quite clear that these increases in electric power generation cannot be achieved with present technology without seriously degrading the quality of air, land, and water in the basin.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Programs are available through the U. S. Department of Agriculture and the State of Wyoming to help solve many of the problems and meet many of the needs of this river basin. This chapter lists some administering agencies and briefly describes their current programs. Some existing projects are also briefly described.

SOIL CONSERVATION SERVICE

The Soil Conservation Service (SCS) assists conservation districts in giving technical assistance to individuals, groups, organizations, towns, cities, counties, and state governments in reducing costly waste of land and water resources and in using them according to their capabilities. This is accomplished through unified planning that combines all the technologies, considers all the resources, and recognizes the human interests that apply to each area of land and water use. The major SCS programs available to residents of the basin are described below.

Assistance to landowners

The SCS has a basic continuing program of providing technical assistance in the conservation of land, water, and related resources as requested by landowners and state and local governments which have planning authority. Conservation districts provide local direction, leadership, and coordination of this program.

There are about 2,400 landowners and operators who have signed agreements to cooperate with conservation districts in the basin. They own or lease about 4,400,000 acres of land including about 800,000 acres of federal land. Nearly 2,000 conservation plans have been developed for about 3,300,000 acres of land. The following are some of the conservation practices on the land in 1971.

About 250 of the 2,230 miles of irrigation canals and laterals have been lined to reduce water losses. About 1,489,000 acres of rangeland have planned grazing systems. Over 1,200 miles of drains have been installed, and nearly 160,000 acres of cropland have been leveled or smoothed for better water management. About 59 miles of streambank have been stabilized. Eighty-two miles of pipe for livestock water, 62,000 water control structures, 143 sprinkler systems, 200 other irrigation system improvements, 282 grade stabilization structures for erosion control, 12,000 miles of fencing for better range use, 250,000 acres of brush control for better vegetation, and 240,000 acres of conservation rotation cropping systems to improve the soil are examples of the conservation work planned and applied to 1971. About 86 different reportable types of conservation practices have been reported. Five of these involve about 35,000 acres of land which have been converted to less intensive uses to protect the soil and enhance wildlife habitat and recreation uses.

Soil surveys and water supply forecasting are supporting activities in planning the wise use of land and water. Detailed soil surveys have been completed for about 1,900,000 acres in the basin, and generalized soils maps are available for the entire basin. This information can be obtained by landowners from the local SCS offices. Water supply forecasts are published monthly from February through May each year for the nine major water source areas in the basin. Some information from these forecasts is published in local newspapers. More detailed information can be obtained from local SCS offices. Interested individuals may request to have their names placed on the regular mailing list and receive a copy of each monthly forecast.

Watershed protection and flood prevention projects

The SCS provides technical and cost-sharing assistance in planning, designing, and installing land treatment measures and structural works of improvement in small watershed projects. These projects are designed to reduce floodwater, erosion, and sediment damages and to promote other water and related land management and development practices as desired by the local sponsors of these projects. Applications for assistance are submitted to the Secretary of Agriculture through the Wyoming State Conservation Commission and the State Conservationist of the SCS.

There is one existing watershed project in the basin. This is the Candy Jack Watershed Flood Protection Project in and near the town of Thermopolis. About 4,000 feet of large diameter pipe have been installed to protect about 100 homes and 10 businesses on about 400 acres from frequent flooding. The Town of Thermopolis and the Hot Springs Conservation District were the sponsoring local organizations for the project.

Resource Conservation and Development Project (RC&D)

The SCS is responsible for coordination of U. S. Department of Agriculture RC&D activities and provides technical and financial assistance to locally sponsored RC&D projects. The objective is to expand socio-economic opportunities for the people of an area by assisting them in developing and carrying out plans of action for the orderly conservation, improvement, development, and wise use of their natural resources.

Applications for projects are submitted to the Secretary of Agriculture through the Wyoming State Conservation Commission and the State Conservationist of the SCS. When a project is authorized for planning assistance, a coordinator is appointed who assists local sponsors in developing a plan. This takes from 6 months to a year or more. Most projects have citizen and advisory committees for agriculture, forestry, water resources, business and industry, transportation, health, education, recreation and wildlife, and community facilities. Policies and priorities are set by a steering committee or executive council composed of the representatives from the sponsoring units of government. The

project then becomes eligible for technical and financial assistance in project measures.

At the present time an application has been approved, and a project plan is being developed for the Bighorn Basin RC&D Project for the five counties which include most of this river basin (Big Horn, Fremont, Hot Springs, Park and Washakie Counties).

FOREST SERVICE

The U. S. Forest Service provides technical assistance to the state and private owners through cooperative agreements with the State Forester. It administers national forest lands under the multiple use concept to provide forest projects, recreation, forage, and watershed protection.

Cooperative state-federal forestry programs

The U. S. Forest Service and the Wyoming State Forestry Division of the State Land Office cooperate in several programs. The Clarke-McNary Cooperative Fire Control Program in Wyoming was 15 years old on April 8, 1974. Since 1959, 18 counties, the State Game and Fish Commission, and the State Recreation Commission have made formal agreements with the State Board of Land Commissioners for improved fire protection on over seven million acres of state and private forested and nonforested watershed lands. The effect of the program is bringing basic organized fire protection to all rural lands within each participating county. However, in the basin, only Fremont and Hot Springs Counties are covered by cooperative fire control agreements.

Under the authority of the Cooperative Forest Management Act of August 25, 1950, the State of Wyoming entered this Cooperative Forest Management Program on January 5, 1962. The purpose of the program is to improve and maintain the productivity of state and private forest lands; to reduce waste in harvesting, marketing, and in the primary processing of forest products; and, by so doing, assist in increasing the income and general welfare of the people of the state. Technical forestry assistance is provided to private forest owners in forest management planning, timber sales, utilization and marketing of forest products, tree thinning, forest protection, etc. Similar service is provided to processors of primary forest products in locating raw material, operation and layout of mill and processing equipment, and otherwise promoting increased efficiency in the primary processing of forest products.

The objective of the Forest Pest Control is to protect state and private forest resource values against damage and loss caused by forest insects and diseases. This is accomplished through continuing and periodic activities to prevent, detect, evaluate, and suppress forest insect infestations and disease conditions on state and private lands. Participation in the program is carried out under the Forest Pest Control Act of August 1947.

The State Forestry Division cooperates with the Forest Service and the Soil Conservation Service in the planning and development of small watershed projects. The division is responsible for the examination and recommendation of land treatment measures on all classes of state land and private forested land. These recommended measures are for range improvements, tree planting, erosion control, etc.

Resource Conservation and Development Projects are an example of cooperation between federal, state, and county agencies, local organizations, and local people. The Forest Service and the State Forester are participating in the Bighorn Basin RC&D Project.

On July 1, 1967, the State of Wyoming entered the Title IV Tree Planting Program (Agricultural Act of 1956). The objective of the program is to bring state-owned forest land up to maximum production by appropriate reforestation methods including site preparation, direct seeding, and tree planting. Reforestation of state lands is currently proceeding at the rate of approximately 100 acres per year. At the present time this program is not funded to include this study area. Under the provisions of the Clarke-McNary Act of 1924, private landowners may obtain tree seedlings for windbreaks, shelterbelts, and forest plantings from the University of Wyoming through extension county agents.

The Wyoming State Forestry Division and the U. S. Forest Service have cooperative agreements with Big Horn, Park, and Washakie counties for land use planning, coordination, and cooperation.

National forest development and multiple use programs

Table VI-1 summarizes the land treatment and structural measures currently planned under existing programs for the national forests in the basin. The measures listed in the table are included in the following programs:

Water resource programs

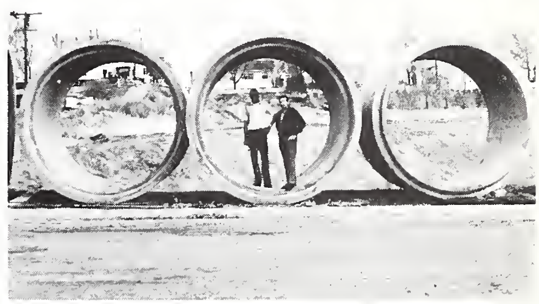
Currently planned watershed management practices include 5 miles of gully control and coordination of other resource uses with watershed management. Planned measures benefiting watersheds include range revegetation and type conversion on 8,300 acres, 350 miles of range fence to protect problem areas and newly established vegetation, and reforestation and afforestation of 5,400 acres (table VI-1). In addition, thinning, release, and weeding planned primarily to benefit timber resources can have a secondary effect of increasing water quantity by reducing evapotranspiration.

Timber resource programs

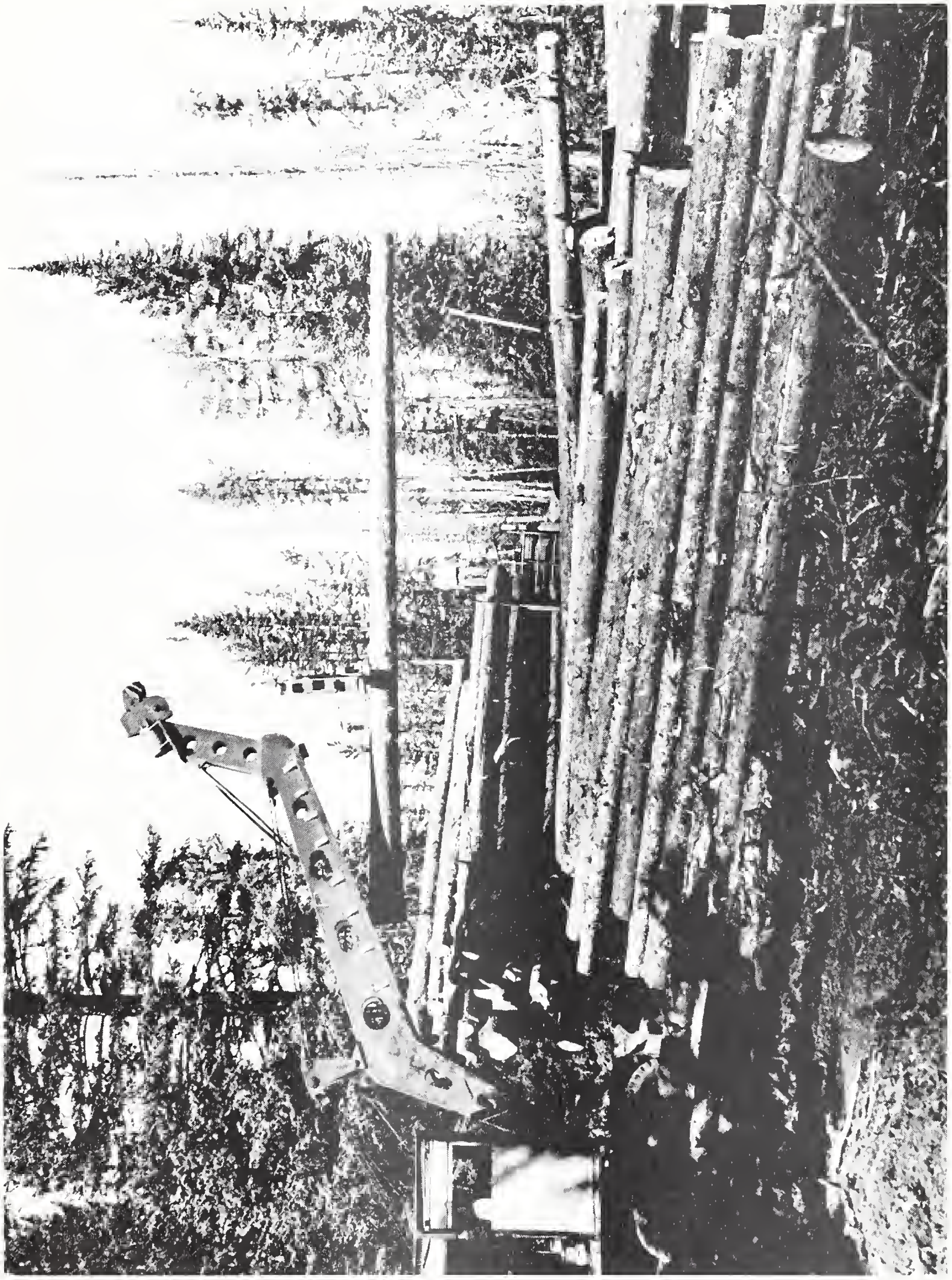
Timber is an important product of the national forests, and as projections in Chapter III indicate, increasing demands are expected in the future. Timber management activities planned under existing

The SCS assists conservation districts by providing technical assistance to landowners.

A large diameter pipeline now provides flood control for the Candy Jack Watershed.



The Recreation and Tourism Committee meets to help develop the Bighorn Basin RC&D plan.



Timber harvest management is just one of the activities of the U. S. Forest Service.

U.S. FOREST SERVICE PHOTO

PLATE 25

programs include up-to-date inventories on all national forest lands; better sale preparation and administration; reduction of insect and disease losses by 50 percent; improved utilization of available timber on sale areas and from conversions and other clearings; better accessibility by constructing 1,370 miles of roads and 44 bridges; release, weeding, thinning, and pruning on 23,100 acres; reforestation and afforestation on 5,400 acres of land; reduction of fire losses; and continued research to improve genetic characteristics of trees and provide better silvicultural practices (table VI-1). Achievement of these planning goals in the next 10 to 15 years will have some effect on timber supplies in the 1980-1990 period, but most will come in 2000 to 2020 and beyond.

Range resource programs

The development and management activities planned under existing range resource programs are: complete allotment inventories and management plans for all national forest land; revegetation, plant control, and type conversion on 14,600 acres; and construction of 355 miles of range fence, 160 miles of stock distribution trails, and 250 stockwater developments.

Recreation resource programs

Most of the outstanding natural attractions and potential outdoor recreation areas are in the national forests. It is the objective of the Forest Service to develop and manage these recreation resources to meet public demand in terms of kind, quantity, and quality. Current Forest Service programs are adequate to supply projected outdoor recreation sites for most land-based activities through the year 2000. Some planned measures are 1,300 miles of trail construction and improvement, 1,370 miles of road construction and improvement mentioned previously, and 60 roadside observation sites, vista points, and scenic turnouts.

Fish and wildlife habitat resource programs

Wildlife and fish resources attract many visitors, and this use is expected to increase. The resources are considered adequate to meet current demands in spite of past reductions in the amount and quality of habitat. The Forest Service program is designed to enhance wildlife and fishery resources, restore forest quality, and mitigate losses from development and land use changes.

Measures planned for the next 10 to 15 years include about 410 miles of stream habitat improvement, lake habitat improvement on 1,160 acres, establishment and release of wildlife forage plants on 30 acres, and 3 miles of fencing to protect key wildlife areas. The watershed programs which reduce erosion and sediment will have a favorable effect on fisheries as water quality is improved or maintained.

Table VI-1--Land treatment and structural measures currently planned under existing programs for the Shoshone and Bighorn National Forests in the river basin

Item	Unit	Amount
Range revegetation - plant control and type conversion	acres	14,600
Range management - stock distribution trails	miles	160
Range management - fences	miles	355
Range management - water development	each	250
Reforestation and afforestation - planting and seeding	acres	5,400
Timber management - release, weeding, thinning, and pruning	acres	23,100
Fish habitat improvement - streams	miles	410
Fish habitat improvement - lakes	acres	1,160
Wildlife habitat management - establish forage plants and release wildlife food plants	acres	30
Wildlife habitat restoration and development - protect key areas by fencing	miles	3
Trail construction and improvement	miles	1,300
Road construction and improvement	miles	1,370
Roadside observation sites	each	10
Road, trail, and stock driveway bridges	each	44
Erosion control:		
Gullies	miles	5

Source: Developed by U.S. Forest Service from Project Work Inventory Data.

ECONOMIC RESEARCH SERVICE

The Economic Research Service conducts national and regional programs of research, planning, and technical consultation and services pertaining to economic and institutional factors and policies which relate to the use, conservation, development, management, and control of natural resources. This includes estimating the extent, geographic distribution, productivity, quality, and contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials, and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and the recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

The ASCS has administered the Rural Environmental Assistance Program or a similar program for a number of years. This program has been discontinued, but a new Rural Environmental Conservation Program is being developed to accomplish similar goals. The major purpose of these programs is to improve the quality of life for all people by helping farmers and ranchers to prevent pollution of land, water, and air and to conserve soil, water, woodland, and wildlife resources. This is done with financial assistance through the ASCS and with technical assistance of the SCS and the Forest Service.

The major types of practices encouraged are those which establish, improve, or protect the soil with a cover of trees, grasses, or legumes; provide primarily for the conservation or safe disposal of water; provide for pollution abatement or environmental enhancement; and provide protection from erosion. Emphasis is given to enduring practices and those which benefit low income farmers, community efforts, and youth and minority groups.

A farmer or rancher who desires assistance must file a request before he starts the practice for which he desires assistance. Approval is based on a decision as to the priority of the practice. Cost-sharing is based on acceptable completion and maintenance of the practice. Groups of two or more are encouraged to participate in pooling agreements. Cost-sharing rates vary by practice.

Over 886 farms participated in the REAP program in 1971. Table VI-2 gives data concerning major kinds of assistance provided during the year for the five-county area comprising most of the river basin.

FARMERS HOME ADMINISTRATION

The Farmers Home Administration provides financial assistance to individuals and organizations (private or public) and technical and management assistance. The overall objective is to strengthen family farms and rural communities. There is a Farmers Home Administration office serving every rural community in the United States.

In the broadest sense, the legislative authority for the various loan programs administered by the Farmers Home Administration is the Consolidated Farmers Home Administration Act of 1961, as amended. Authorities under the various sections of the act are very broad and include in part the following specific loan purposes: purchase, enlargement, and improvement of family-type farms; farm operating expenses, purchase of farm machinery, livestock, and equipment; construction of rural homes and farm service buildings; development of community water and waste disposal facilities, (PL-87-128, Section 306); development of recreational facilities; watershed development (PL 566, Section 8); soil and water conservation; shifts in land use; rural renewal projects; and resource conservation and development (PL-87, Section 703).

Table VI-2--Summary of REAP assistance, 1971

County	Cost-Shares	Control Competitive Shrubs	Establish Permanent Cover	Land Leveling	Reorganize Irrigation Systems
		acres	acres	acres	acres served
Big Horn	$106,087	5,850	1,830	523	12,510
Fremont	$ 70,168	375	1,650	395	9,950
Park	$ 89,074	3,500	943	411	3,885
Hot Springs	$ 18,365	5,350	275	70	412
Washakie	$ 39,925	3,540	98	124	855
Totals	$323,619	18,615	4,796	1,523	27,612

There are essentially no limitations which would restrict or prohibit extension of financial assistance to correct water and related land resource problems. Farmers Home Administration loans supplement, and in no case, compete with credit provided by other lenders.

COOPERATIVE EXTENSION SERVICE

The Extension Service is a part of the Cooperative Extension Service partnership. Federal, state, and county governments share in financing, planning, and carrying out information and educational programs. The Extension Service acts as the educational agency of the U. S. Department of Agriculture. Extension specialists and county agents cooperate with other agencies to provide local information relating to conservation programs, weed control, crop culture, animal culture, herbicides, pesticides, fertilizers, homemaking, and other types of information and assistance.

WYOMING STATE AGENCIES

Wyoming State Conservation Commission

The Wyoming State Conservation Commission assists and guides thirty-nine conservation districts throughout Wyoming in the development of conservation education programs, information programs, and total resource conservation programs to promote multiple and wise use of our natural resources in urban and rural development. Each conservation district is governed by five local citizens and provides the starting point for small watershed projects (PL-566) and resource conservation and development projects (RC&D) in the state. Conservation of our soil and water resources is improved as the districts assist in irrigation projects, mine reclamation,

soil surveys, and conservation planning for individuals, groups, and units of government.

The Wyoming State Conservation Commission is the state agency designated by the Governor to review and approve small watershed projects and RC&D projects applications and plans. The Commission sets the priorities and direction for Soil Conservation Service activities on small watershed projects. The Commission may also assist in accelerating work on these projects by employing consultants to acquire basic information for preliminary investigations of feasibility.

Wyoming Department of Agriculture

The State Department of Agriculture is assisting agriculture in Wyoming to meet the needs of the present and the future and to add to the economy of the state. Departmental programs related to land and water and related resources development are described below.

Division of Plant Industry

The Division of Plant Industry administers a Weed and Pest Program which provides funds and technical assistance to landowners. Each of the five counties in the basin is a Weed and Pest Control District. These districts participate with all agricultural groups in the control of designated weeds and pests. The division also offers technical assistance in brush control, insect control, and plant diseases, and, on a routine basis, sample fertilizers, pesticides, and seeds for label compliance.

Division of Markets

The Division of Markets furnishes technical assistance in the fields of transportation, marketing, and statistical information to assist in the development of feasible programs with regard to freight rates, agri-business, export, and import of all agricultural products. The division has the responsibility of grading and inspection of produce entering and leaving the state. The Weights and Measures Section of this division inspects and tests all commercial weighing and measuring devices in the state and checks the correct quantity and weight of products and merchandise offered for sale.

Division of State Laboratories

The Division of State Laboratories, located on the University of Wyoming campus at Laramie, furnishes the expertise and equipment necessary to analyze fertilizers, pesticides, drugs, feeds, water potability, food, or any commodity as it pertains to humans or animals.

Division of Food and Drug

The Division of Food and Drug surveys food producers and processors for compliance with minimum standards. Routine survey and sampling of food

and food products is also conducted to determine wholesomeness and compliance with label guarantees. Dairy producers and processors must also conform to established minimum requirements as set by law.

Division of Agricultural Planning and Development

The Division of Agricultural Planning and Development has a responsibility to help the development of the agricultural sector of the state's economy. This is accomplished through conducting economic and statistical studies, planning for agricultural development, and public involvement, information, and education programs. These activities are done in coordination with various agencies of local, state, and federal governments.

Wyoming Department of Economic Planning and Development

The Wyoming Department of Economic Planning and Development (DEPAD) is charged with the planning for and development of the physical and economic resources of the state. The department consists of the office of economic planning and development; administrators and councils of the division of water, industrial and mineral development; and the board of economic planning and development.

The division of water development is responsible for activities in connection with state financial assistance for water development projects. The department determines engineering and economic feasibility in order to base recommendations to the Wyoming Farm Loan Board for loan approval. Loans in an amount not to exceed $150,000 are available to court approved water districts with taxing authority, agencies of state and local government, persons, corporations, and associations in Wyoming. A majority of the shareholders must be Wyoming electors. Court approved water districts with taxing authority are eligible for funds in excess of $150,000. The annual interest rate on reservoir loans is 4 percent for a term not to exceed 40 years. Sprinkler irrigation loans are limited to a maximum term of 15 years at an annual interest rate not less than 4 percent and not greater than 8 percent to be set by the Farm Loan Board. The interest rate for loans other than reservoirs was set at 5.5 percent effective September 6, 1973. Other activities of the Division of Water Development include entering into contracts and agreements, reserving water resources, entering into water service contracts, and setting water rates for that service.

The division of industrial development is responsible for investigations and preparing plans and specifications for development in connection with any resource of the state, industry or business within the state and attracts new industry into the state. The division makes studies of soil and its uses, and makes studies to promote and protect the forest and range areas within the state.

The division of mineral development makes studies of all mineral resources, mines and mining, the exploration, development, conservation

and production of oil and gas and other minerals, and prepares state legislation pertaining to resources of the state.

The Chief of state planning is responsible for the comprehensive state plans for the physical and economic development of the state.

Wyoming State Forestry Division

The Wyoming State Forestry Division administers and manages all forested state lands, participates in cooperative state-federal forestry programs described earlier in this chapter, and provides assistance to private landowners. Major activities in the assistance to private landowners are for fire control, forest management, pest control, and tree planting. This office cooperates with federal agencies in assisting in the planning of small watershed projects and resource conservation and development project measures.

Wyoming State Engineer

The State Engineer is responsible for the supervision of the state's water resources. Unreserved water may not legally be diverted from any natural source until a permit is obtained from the State Engineer. The Board of Control, with the State Engineer as president, adjudicates water rights and provides the field supervision of water rights and uses. The State Engineer is also responsible for the coordination of state water resources planning. The Wyoming Water Planning Program has developed a Framework Water Plan. The State Engineer requested this study to assist this state organization and provide the state with more information about USDA program opportunities in the basin.

Wyoming Public Service Commission

There are three areas of water and related land resource development where the Public Service Commission has programs. They are: (1) rural, domestic, and livestock water supply, (2) municipal and industrial water supply, and (3) rural power supply. The commission is charged by law with the regulation of all utilities in the State of Wyoming including water utilities and Rural Electric Associations. Individuals, companies, or associations that intend to provide a utility, commodity, or service to the public must first obtain a certificate of public convenience and necessity from the commission. The commission does not provide financial assistance.

Wyoming Department of Environmental Quality

The Water Quality Division of this department is presently the state planning, coordination, and approval agency for water pollution controls and solid waste management programs which can receive federal assistance through the Environmental Protection Agency. The town of Lovell and the north Big Horn County community are presently developing a solid waste collection and disposal system through this program.

Wyoming Game and Fish Department

The State Game and Fish Department is authorized to enter into cooperative agreements with federal agencies, corporations, associations, individuals, and landowners for the development of state control of wildlife management and demonstration projects. Many public access areas for hunting and fishing have been established through this program. The Ocean Lake and Yellowtail Wildlife Habitat Management Units are managed by the Department through various agreements with federal land administering agencies. The Department cooperates with USDA agencies in providing technical assistance to landowners who want to improve fish and wildlife habitat.

Wyoming Recreation Commission

The Wyoming Recreation Commission administers the Boysen and Buffalo Bill State Parks in the basin. It also administers the Land and Water Conservation Fund through which financial assistance is provided to tax-based legal entities for the development of outdoor recreation areas and facilities. The commission administers state-owned historic sites, monuments, and markers. It also administers the Historical Preservation Fund and the Snowmobile Registration Act.

Special purpose districts

Districts are political subdivisions of the State of Wyoming. Several single purpose districts such as irrigation districts, drainage districts, and flood control districts may be created under state law. Others, such as conservation districts, watershed improvement districts, and water conservancy districts, can be multipurpose in nature. Each kind of district has unique powers and limits of power. Conservation districts promote the wise use of water and related land resources through the cooperative action of landowners. They secure technical assistance from the SCS or other agencies, help cooperators secure needed supplies and materials not readily available, and sometimes secure special equipment needed to apply conservation practices on the land. Watershed improvement districts are usually formed to provide local sponsorship, leadership, land rights, and funds for watershed projects.

EXISTING RECLAMATION PROJECTS

About 168,600 acres of cropland have been developed in the basin through reclamation projects. The existing projects are listed below.

Owl Creek Unit

This is a project which includes a storage dam and pumping facilities to ultimately provide supplemental water to 13,123 acres of irrigated land. Water is presently pumped from the Bighorn River to supplement the water from Owl Creek for about 3,210 acres of land in the Lucerne area. When

finally completed and sealed, Anchor Reservoir will store 17,300 acre-feet of water to assure a water supply for about 9,913 acres. In 1972, 10,921 acres were being irrigated.

Boysen Unit

The Boysen Dam is a flood control, power, and flow regulation dam for irrigation, municipal, and industrial uses. The Boysen Unit improves downstream late water supplies and provides supplemental water for upstream lands by exchange, but no irrigation development is included in the Unit. In 1972, 50,520 acres received a supplemental water supply from Boysen Reservoir.

Shoshone Project

This project is based on storage and flow control by Buffalo Bill Dam. Irrigated lands for this project extend from Cody to Kane, Wyoming, and include about 92,814 acres presently irrigated by the project. Power is generated at Buffalo Bill Dam and at Heart Mountain Power Plant.

Hanover-Bluff

This is a pumped water supply project using Bighorn River water controlled by the Boysen Dam. There are 7,301 acres presently irrigated by this project.

Riverton Reclamation Project (Now a unit of the Pick-Sloan Missouri Basin Project)

Water is diverted from the Wind River near Morton to supply about 54,281 acres of irrigated land from Pilot Butte to the Boysen Reservoir. Bull Lake storage is involved in this project. Power was generated at Pilot Butte Reservoir until 1973. A total of about 56,487 irrigable acres could be irrigated by the project.

EXISTING IRRIGATION PROJECTS DEVELOPED THROUGH THE BUREAU OF INDIAN AFFAIRS

Nearly 39,000 acres on the Wind River Indian Reservation are irrigated from projects developed through federal assistance.

EXISTING IRRIGATION PROJECTS THROUGH PRIVATE DEVELOPMENT

Although federally developed and assisted irrigation projects are extremely important to the economy and social welfare of the river basin, over 60 percent of the irrigated area or about 331,000 acres have been privately developed. Individual systems on farms and ranches comprise a noteworthy part of this development. More impressive are the group enterprise developments which have built reservoirs, canals, laterals, diversion dams, and control structures to provide water to many farms. Early developments were much assisted by the provisions of the Carey Act. These

systems are constantly being improved through private initiative, often with the assistance of the programs administered through the USDA described earlier in this chapter.

New private developments are still possible and can be assisted through state programs also described earlier in this chapter.

EXISTING PROJECT OF CORPS OF ENGINEERS

The town of Greybull is protected against frequent flooding and ice jams of the Bighorn River by about 14,000 feet of levee constructed by the Corps of Engineers. The Corps also has authority to provide regulations for existing dams in the basin to prevent or reduce flood damages.

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management administers the unreserved public lands in this basin and the nation. These lands produce wildlife and fish habitat, timber and other wood products, land and water recreation opportunities, minerals, and grazing for livestock. The Bureau has an active program of range and watershed improvement through brush control, contour terracing and furrowing, fencing, seeding, waterspreading, and building detention dams, diversions, stock water ponds, and spring developments. It also has an active program of recreation site selection, withdrawal, and development.

Public lands are classified for retention in public ownership or disposal to private individuals or other public agencies. Some lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes. Some have been transferred to the Bureau of Reclamation for project developments. Some lands are available for desert land entry to qualified individuals.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

The purpose of this chapter is to describe some of the physical capability of water and related land resources to support development in the basin. Specific proposals for projects and programs are described in later chapters. The reader should keep in mind that economic, legal, sociological, and political restraints and limitations are generally not considered in discussing these resource potentials. The reader should also keep in mind that the development of a resource for one purpose may reduce its potential for other purposes.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

Presently irrigated cropland

Much of the presently irrigated cropland in the basin is producing at less than its sustained yield capacity. About 80 percent of the irrigated cropland in the basin could have significantly improved production through improved management, land treatment, and water distribution systems.

About 34 percent, or 182,000 acres of the presently irrigated cropland, could have increased yield if provided a full supply of irrigation water. Most of these are haylands and pasture. If about 360,000 acre-feet of water could be brought to these lands to supplement existing water supplies for second and third growth periods, they could support an increased production of 50 to 100 percent over present yields. With improved water supply there would also be increased incentive for improved management, land treatment, and water distribution systems.

Potentially irrigable land

Data from soil surveys and reconnaissance studies of the basin indicate that large tracts of land, not presently irrigated, are suitable for irrigation. These potentially irrigable lands have suitable soils and land slopes for irrigated agriculture. Many of these tracts are adjacent to lands which are presently irrigated. A large portion of these lands are owned by the federal government, but other areas are owned by state and private interests. Figure II-7 is a map showing both presently irrigated and potentially irrigable lands. Table VII-1 lists the estimated areas of irrigable land in each subbasin and estimated water requirements for full irrigation at 50 percent project irrigation efficiency.

Potential on range and dry pastureland

If all private and state range and dry pastureland were to receive improved management and treatment where needed, they could produce an estimated additional 369,000 animal unit months (a.u.m.) of roughage feed for domestic livestock and grazing wildlife. This corresponds to an increase of an average of 0.13 a.u.m. per acre on the 2,733,700 acres of this land needing improved management and treatment.

Table VII-1--Potentially irrigable lands and estimated irrigation requirements by subbasin in Wyoming

Subbasin name	Irrigable areas	Net field irrigation water demand 1/	Projected irrigation water requirement 2/
	----acres--	---inches----	-1,000 acre-feet-
Wind River	181,600	23	696
Bighorn River	642,800	25	2,678
Clarks Fork	41,600	24	166
Little Bighorn River	9,600	20	32
Total	875,600	24.5	3,572

1/ Estimated average for all crops and associated new vegetation in each subbasin.

2/ Estimated 50 percent irrigation project efficiency.

POTENTIAL SURFACE WATER DEVELOPMENT

Estimated water savings through increased irrigation efficiencies

About 66 percent or 356,830 acres of the presently irrigated cropland in the basin benefit from an abundant basic water supply. Some of these lands fail to receive a full irrigation supply because of inefficiencies in the transportation, management, and application of irrigation water. If project irrigation efficiencies on these lands were increased 10 percent, about 230,000 acre-feet less water would be diverted for irrigation each year, irrigated lands would be more evenly irrigated, increased production would result, and instream water quality would be enhanced. This does not represent a net savings of water, however, since much of the presently diverted water returns to the natural streams as irrigation tailwater or as ground-water return flow.

The potential for saving water through increased efficiencies is not so good in areas where the basic streamflow is less than enough to supply a full irrigation supply annually. Some of the irrigated lands in the basin do not receive even one complete irrigation in dry years. Increased efficiencies on these lands would result in increased production, improved water quality, and better land use. However, one of the main incentives to increase water use efficiency in these areas is to use the water on additional adjacent land, and the net result would probably be a reduction of water downstream.

Estimated water savings potential in phreatophyte areas

There are an estimated 198,400 acres of phreatophytes in the basin. These include cottonwood trees, greasewood, salt cedar, tules, salt grasses, willows, and other species. They use about 346,500 acre-feet of water each year. About 80 percent of this area is riparian vegetation along natural streams. The remaining 20 percent of the area is associated with agricultural irrigation development. Any reduction in consumptive uses by these phreatophytes should result in a net water savings of nearly the same amount.

If a 25 percent reduction in 20 percent of the area and 10 percent reduction in 80 percent of the area could be achieved, this would be a savings of about 45,000 acre-feet per year. These savings could conceivably be achieved through chemical and mechanical removal of plants, through improved agricultural water management resulting in less water flow to those phreatophytes associated with agriculture, installation of new and improved drainage systems to lower water tables, and other practices. Any attempt at phreatophyte reduction should be carefully evaluated with regard to effects on fish and wildlife habitat.

Potential impoundments

Even in the most water-short areas, water could be stored during high spring flows and short summer floods to provide supplemental irrigation water to presently irrigated lands. The mainstreams of the Wind River, Bighorn River, Clarks Fork, Shoshone River, and several of their major tributaries are water-rich areas which supply most of the water flowing from the Wyoming portion of the basin. According to interstate compact allocations, about 2,400,000 acre-feet or more might be stored and used in Wyoming.

A list of possible reservoir sites is given in table VII-2. Locations are shown on the map of figure VII-1. A large number of sites are listed in the table and shown on the map. They represent physical locations where between 200 and 25,000 acre-feet of water might be stored in a topographically possible site. However, there are several reasons why this list is deceptive. A large number of these sites are unfavorable from a geologic point of view. Suitable soils for fill materials are not readily available at many sites. Many of the sites are so small they would solve only a small part of the water shortage problem. Others are in locations where the storable water supply is very limited. Some sites require large dams to store the expected amounts of water. For these reasons the actual potential for new storage sites is very limited. Land rights are not considered to be a problem except as sites conflict with forest and wilderness area uses.

Potential for intrabasin transfer

If all storable water in water-short areas were stored, these areas would still require about 174,600 acre-feet more water each year for a

Table VII-2--Possible reservoir sites

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Primitive area 4/														
Grave Lake	14ela-4	36		36N	104W	2		4,500		200	22,000	4.89	I	6
Gill Park	14ela-2	44	6,780	32N	102W	28	(19) + (20)sq.mi.	710		300			I	1 + 6
Bills Park	14ela-2	45		32N	102W	32, 33			Unsurveyed					
Upper Cloud Creek	14e4-6	122	1,182	51N	86W	29	42	920	22	300			I	5
Middle Cloud Creek	14e4-6	123	1,183	51N	86W	29	30	440	15	380			I	5
Absaroka Wilderness 4/														
	14e6-1	154		47N	107W								I	
	14e6-1	153		46N	107W								I	
	14e6-1	152		45N	108W								I	
Forests														
	14c-3	170											I-R	
	14c-3	171											I-R	
	14c-3	172											I-R	
	14c-1	173											I-R	
	14c-1	174											I-R	
	14c-3	175											I-R	
	14c-5	176											I-R Power	
	14c-5	177											I-R	
	14c-3	168											I-R	
	14c-3	169											I-R	
	14e4-6	125		50N	87W								I-R	
	14e5-1	134		46N	103W								I-R	
	14el-4	10		43N	105W								I-R	
	14el-2	8		43N	106W								I-R	
Hough Res.	14el-1a	5		43N	106W	3	164 sq.mi.	30,000			600,000	20.00	I-R	6
Stoney Point	14el-1a	2		42N	108W	25	230 sq.mi.	220,000	200	900	1,640,000	7.45	I-R	6
Torrey Lake	14el-3	6		41N	106W	34	56 sq.mi.	33,000	50	3,180	500,000	15.15	I-R	6
West Tensleep Lake	14e4-4	115	6,307	50N	86W	33		1,176		500			I-R	5
Tensleep Meadows	14e4-4	116	4,557	48N	86W	5		12,353		450			I-R	5
Tensleep Meadows	14e4-4	117	1,329	48N	86W	6		13,488		45			I-R	5
Pete's Lake	14ela-2	46	5,384 6,781	32N	101W	18		762		300	11,700	15.35	I-R	1
Middle Popo Townsend	14ela-2	47	4,555	32N	101W	26							I-R	1
Louis Lake	14el[illegible]-1	48	4,063	30N	101W	1	7½ sq.mi.	8,014		240			I-R Power	2
Porcupine Creek	14e-28	167	2,016	56N	92W	12		14,661	120				I-R	5
	14e7-[illegible]	181		57N	87W								I-R	
Willett Co.	14e-22	146	4,721	53N	88W	21		869		400			I-R	5
Moraine Creek #1	14e-22	145	6,848	53N	88W	22		1,151		500+			I-R	5
Shell Lake	14e-22	144	4,595	52N	87W	17		530		350			I-R	5
Medow	14e4-6	126	1,181	51N	88W	3		285	13.5	610			I-R	5
Medicine Lodge	14e4-6	127	1,185	51N	88W	11	100	2,248		500 + 450			I-R	5
Paintrock	14e4-6	128	1,180	51N	88W	13	77	1,296		1,400			I-R	5
	14e4-6	131		51N	87W								I-R	

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Solitude	14e4-6	124	1,186	51N	87W	36	155	8,573		580			I-R	5
Private Brooks Lake	14el-1	1		44N	110W	25	12 sq.mi.	9,719	30		32,000	3.29	I-R	6
LeClair														
Warm Springs	14el-3	3		42N	109W	22		3,000	80				I-R	6
Warm Springs Cr.	14el-3	4		42N	108W	34		5,000						
								16,000					I-R	
North Fork	14el-3	7		41N	105W			60,000			5,000,000	83.333	I-R-F	6 + 2
	14el-2	9		7N	6W								I-R-F	
Wind River EF #2	14el-4	11		8N	5W			41,040		739			I-R-F	4
Wind River EF #1	14el-4	12		6N	6W			122,560		2,006			I-R-F-S	4
	14el-5	13		5N	5W								I-R-F-S	
Mud Lake #1	14el-6	14		4N	6W			26,208		200			I-R	4
Dinwoody Lake	14el-6	15		5N	5W			28,382		2,000			I-R	4
Dinwoody Lake	14el-6	16		5N	5W			130,620		1,900			I-R-F-S	4
Dinwoody Lake	14el-6	17		5N	5W								I-R-F-S	
Crow Creek #1	14el-5	18		7N	4W			36,312		1,373			I-R-F-S	4
Wind River #1	14el-6	19		4N	3W			195,776		4,280			I-R-F-S	4
Bull Lake Cr. #2	14el-7	20		2N	5W			20,352		840			I-R	4
Bull Lake Cr. #1	14el-7	21		2N	4W			75,740		2,240			I-R	4
Wind River #5	14el-7	22		3N	2W			40,629		2,200			I-R-F-S	4
	14el-8	23		4N	2W								I-R	
	14el-8	24		6N	3W								I-R	
	14el-8	25		6N	3W								I-R	
	14el-8	26		6N	3W								I-R	
Dry Creek	14el-8	27		5N	2W			22,508		3,640			I-R-F	4
Wind River #4	14el-8	28		3N	1W			62,650		2,960			I-R-F-S	4
Wind River #6	14el-9	29		3N	1E			70,494		4,540			I-R-F-S	4
	14el-10	30		3N	1E								I-R-F-S	
	14ela-4a	31		2N	3W								I-R	
Sage SF Creek #1	14ela-4a	32		2N	2W			35,630		1,600			I-R	4
Sage Creek #1	14ela-4a	33		1N	1W			14,456		1,720			I-R-F	4
Little River SF #2	14ela-4	34		1S	4W			56,430		1,003			I-R	4
	14ela-4	35		1N	3W								I-R-F	
Grave Lake	14ela-4	36		33N	104W	2		4,500		200	22,000	4.89	I-R	6
Little W. River SF #1	14ela-4	37		1S	3W			17,100		1,056			I-R	4
Little W. River	14ela-3	38		1N	1E			55,080		3,920			I-R-F	4
Sharp Nose Draw #1	14ela-3	39		1S	2E			2,380		1,480			I-R	4
Sharp Nose Draw #2	14ela-3	40		1S	2E			15,336		1,520			I-R	4
	14ela-2a	41		33N	101W								I-R	
Surrell Cr. #1	14ela-2a	42		2S	1W			16,688		840			I-R	4
Popo Agie River #2	14ela-1	43		2S	1E			38,781		1,880			I-R-F	4
Onion Flat	14ela-1	49		32N	99W								I-R	
	14ela-1	50		32N	99W	25		9,000		1,800	300,000	33.33	I-R	2
	14ela-1	51		33N	99W								I-R-F	

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Popo Agie River#1	14ela-1	52		2S	2E			102,336		4,200			I-R-F	4
	14ela-5	53		29N	97W								I-R	
	14ela-5	54		30N	97W								I-R	
	14ela-5	55		30N	97W								I-R	
Smith & Bringolf	14ela-5	56	2,815	32N	96W	16		426		200			I-R-F	1
Beaver Creek	14ela-6	57		2S	4E			27,324		4,200			I-R-F	4
	14el-9	58		2N	2E								I-R-F-S	
Loma Coyote	14e2-1	59	6,772	32N	91W	25							I-R	
Dry Coyote	14e2-1	60	6,765	32N	91W	24		256	46				I-R	5
	14e2-2	61		33N	94W								I-R	
Muskrat Conant	14e2-3	62	2,786	36N	93W	30		2,039					I-R	5
King Gorm Res.	14e2-3	63	1,974	37N	94W	36	290	5,390		2,400			I-R	5
	14e2-1	64	3,418	37N	93W	30		733		600			I-R	5
Queen Thyra	14e2-1	65	1,973	37N	93W	19		1,235					I-R	5
Teapot Gulch#1	14e-4	66		5N	1E			5,022		1,180			I-R	4
Fivemile Cr. #2	14e-4	67		5N	1E			7,776		1,180			I-R	4
Fivemile Cr. #1	14e-4	68		4N	1E			2,100		1,200			I-R-F	4
	14el-9	69		3N	5E								I	
Sagwup Draw #1	14e-5	70		7N	1W			17,157		920			I-R	4
Muddy Creek #1	14e-5	71		6N	1E			57,344		2,580			I-R	4
Shotgun Cr. #1	14e-5	72		6N	1E			7,600		1,180			I-R	4
Blue Draw	14e-5	73		6N	2E			19,968		1,320			I-R	4
Sheep Creek WF #1	14e-5	74		6N	2E			29,128		1,140			I-R	4
Golden Dome #1	14e3-4	75	3,998	40N	93W	35		432		500			I-R-S	5
Golden Dome #2	14e3-4	76	3,999	39N	92W	8		361		480			I-R-S	5
Cottonwood #1	14e-6	77		4N	5E			972		1,240			Sed	4
Cottonwood #2	14e-6	78		5N	5E			21,178		2,680			Sed	4
	14e-7	79		42N	94W								I-R	
	14e3-2	80		39N	88W								I-F	
Snyder Cr. Detention	14e3-2	81	7,133	39N	90W	13	6,079	347					I-F	5
Okie	14e3-2	82	34	39N	90W	34		217					I-F	5
Waterworks #3	14e3-2	83	6,516	38N	90W	4		211 -		1,200			I-F	5
Owl Creek S. Fork Trib.	14e-10b	84	67	43N	95W	1		3,200					I-F	5
Dempsey	14e-10b	85	2,094	44N	94W	31		1,070					I-F	5
Owl Creek SF #1	14e-8	86		8N	3W			22,680		949			I	4
Owl Creek SF #2	14e-8a	87		8N	1E			20,088		1,540			I-R	4
	14e-8a	88		9N	2E								I-R-F	
Owl Creek "Basin"	14e-8a	89	2,095	43N	100W	13		5,231	14.1	2,700			I-F	5
Mt. View	14e-8a	90	4,138	44N	98W	35		5,832	20	3,000			I-R-F	5
	14e-9	91		8N	3E								I-R	
	14e-9	92		8N	4E								I-R	
	14e-14	93		44N	98W	10							I-R-F	
	14e-14	94		44N	98W	4							I	
Little Buffalo	14e-15	95	1,334	47N	99W	4		51,197					I-R	5
Buffalo Creek	14e-15	96	1,753	47N	99W	19		145,000					I-R	5
	14e-15	97		47N	98W								I-R	
Gooseberry Cr.	14e-15	98	1,[illegible]	47N	101W	36		42,505		1,300			I	5
	14e-15	99		47N	98W								I	
Farmers	14e-15	100	3,604	47N	97W	31		14,506		1,100			I	5

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Sunnyside	14e-15	101	1,755	46N	95W	1		522	18	2,000			I-R-F	5
	14e-15	102		47N	94W	31							I-R-F	
Fruitland #2	14e-12a	103	2,936	46N	91W	29		5,318		2,000			I-R	5
Fruitland #1	14e-12a	104	2,935	46N	92W	25		7,245					I-R-F	5
	14e-12a	105		45N	92W								I-R-F	
Fifteen Mile Cr.	14e-19	106	1,337	49N	98W	27		46,081					I-R	5
Wilson #1	14e-17b	107	1,012	47N	92W	26		386					F	5
Wilson #2	14e-17b	108	1,013	47N	92W	23		379					F	5
	14e4-2	109	3,285	43N	88W	17		231		600			I	5
	14e4-1	110		44N	88W								I-F	
	14e4-1	111		42N	88W								I	
	14e4-1	112		43N	88W	35							I-F	
	14e4-1	113		43N	87W								I-F	
	14e4-1	114		43N	87W								I-R-F	
	14e4-4	118		47N	87W								R	
	14e4-5	119		49N	87W								I-R	
	14e4-5	120		48N	89W								I-R-F	
	14e4-6	129		50N	90W								I-R-F	
Thayer Res. #1	14e5-2	130	4,154	48N	104W	14		639		700			I	5
	14e5-1	131		48N	102W								I-R-F	
	14e5-1	132		48N	102W								I-R-F	
	14e5-1	133		47N	103W								I-R	
	14e5-3	135		48N	103W								I-R	
Bawhide Creek	14e5-3	136	1,859	48N	102W	2		34,738					I-R	5
Lake McKinney #2	14e5-4	137	5,389	51N	95W	2		202					I	5
Alpha Sandstone Reservoir	14e5-4	138	3,569	51N	95W	29		579		400			I	5
Sage Cr. Coulder Wiley	14e-25	139	4,149	51N	100W	7		2,057					I	5
Oregon Basin	14e-25	140	242	52N	100W	27	5,106	382,950		150			I-R-S	5
Lithomsen	14e-25	141	4,039	52N	100W	26		1,960					I	5
Thomsen	14e-25	142	3,919	52N	100W	26		1,011					I	5
	14e-26	143		53N	96W								I	
Moberly-Stoddard Divert fr. Trapper	14e-23	147	6,768	53N	91W	34		248		500			I	5
	14e-23	148		54N	91W								I	
	14e-23	149		52N	92W								I	
Bench Canal	14e5-4	150	7,153	52N	95W	18		299		800			I	5
	14e-24a	151	2,262	55N	93W	31	100	644					I	5
Sulphur Creek	14e6-[illegible]	155	5,088	52N	102W	11, 12 13,14,15		18,480		900			I	5
Cody Canal	14e6-3	156	5,089	52N	101W	5 & 6		1,212					I	5
Beck Lake	14e6-3	157	5,090	52N	101W	5 & 6		995					I	5
Goff	14e6-6	158	3,051	54N	103W	26		663		130			I	5

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) : (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Skull Creek	14e-4	159	2,635	54N	103W	24		641	17.2	200			I	5
Melvina Lake	14e6-3	160	4,148	51N	102W	36		937	20	1,000			I-R	5
Melvina Lake	14e6-3	161	2,929	51N	102W	25 + 36		936					I	5
	14e6-3	162		51N	101W								I-R	
Sage Creek	14e6-3	163	2,456	51N	101W	18		1,082					I-R	
	14e6-5	164		54N	99W								I	
	14e6-6	165		55W	97W								I-F	
	14e-27	166		58N	95W								I-R	
	14c-5	179		56N	101W								I	
	14c-4a	180		57N	97W								I-S	

1/ A comparative figure derived from dividing the estimated earth fill in cubic yards by the estimated water storage capacity in acre-feet.

2/ I - irrigation, F - flood protection, R - recreation--fishing, hunting, and boating, S - water supply--industrial, municipal, and domestic. Sed - sedimentation.

3/ Source: 1 - Soil Conservation Service, 2 - Bureau of Reclamation, 3 - Corps of Engineers, 4 - Bureau of Indian Affairs, 5 - Wyoming State Engineer, 6 - Report of Water Resources on the Wind River Basin to Wyoming Natural Resource Board by Bishop & Spurlock 1962.

4/ Sites identified in Wilderness and Primitive Areas are physical possibilities only; approved for construction would require special amendments to the Wilderness Acts.

LOCATION MAP

LEGEND

12● Possible Reservoir Sites

SEE TEXT FOR LISTING OF INDIVIDUAL RESERVOIR SITES

FIGURE VII-1

POSSIBLE RESERVOIR SITES

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

full irrigation supply. If this shortage is to be reduced, new water sources must be developed. One source might be transfer of surface water from the larger streams in the basin. It would be physically possible to build canals and aqueducts from the Upper Wind River to provide irrigation water to most of the presently irrigated lands in both the Wind River and Bighorn River subbasins. Some of the irrigable land in the basin could also be supplied this way. Gravity flow sprinkler systems could be supplied from the main tranportation system. However, this kind of system would be very expensive and probably not economically feasible. Uncertainty with regard to appropriated versus reserved water rights also restrains development of transfers at this time.

Probably more feasible is the potential for developing systems to pump water from the Bighorn River or existing canals. However, pumping and installation costs rapidly increase as distances, pumping heads, and amounts of water increase so that it is not likely that very large scale developments of this type are economically feasible. Most of this development will probably occur through local initiative.

Some projects for development of new lands through storage and transfer of water within the basin have been proposed by the Bureau of Reclamation and are discussed in more detail in chapter IX of this report. More information can be obtained from the Bureau of Reclamation.

POTENTIAL GROUND-WATER DEVELOPMENTS

Ground water in amounts up to 450 gallons per minute (g.p.m.) from depths of less than 100 feet can be developed in valley alluvium along major drainages in the basin. However, the potential for large scale water development from valley alluvium is limited because of thin aquifers and the possibility of depleting surface flows in associated streams.

Supplies of up to 25 g.p.m. may usually be obtained within depths less than 600 feet on the basin floor in bedrock formations of the Tertiary Age. Steeply inclined older formations outcrop around the margin of the basin floor. Aquifers in these formations may yield sufficient water with artesian pressure for irrigation use. Depths to these aquifers vary widely as does the quantity and quality of water obtained from them. The potential for large producing wells of this type is restricted to a narrow band along the margin of the basin floor, and careful site selection is required.

The potential for artificial recharge of aquifers is very limited in the basin. If new lands are developed on the benches in the midwestern portion of the Bighorn River Subbasin, a shallow body of ground water will probably form in gravel deposits which might provide potential for new wells.

POTENTIAL FOR CHANNEL IMPROVEMENTS AND LEVEES

There is potential for channel improvement, streambank protection,

and levee construction to reduce flood damage and streambank erosion on many of the streams and rivers in the basin. However, in practice the installation of these measures is generally restricted to short reaches to protect roads, railroads, towns, bridges, irrigation diversion structures, and cropland.

POTENTIAL FOR WATER TABLE CONTROL

The most suitable method of obtaining water table control is to combine improved irrigation water management and irrigation systems with improved drainage systems. Table VII-3 lists the areas considered to be wetlands in various portions of the basin and their potential for improved water level control.

Of the 97,800 acres that have wet and saline soils, water table control can be improved through improved agricultural water management and irrigation systems improvement for 82,160 acres. This same area would also benefit from improved drainage systems, and 32,170 acres of this land requires improved drainage to achieve effective water table control. The remaining wetlands (15,640 acres) cannot practically be improved by drainage, water management, structural irrigation systems, or any combination of these practices because of topographic position, shallow soils over bedrock, or extremely tight and alkaline soils. These areas can be managed as salt and water tolerant pastures or as wildlife habitat or recreation areas. Those areas which are not suitable for drainage are probably more useful as wildlife habitat than those which are practical to drain.

Some of the area listed as improveable by drainage has been irrigated in the past and will require some irrigation for full production after drainage is installed.

POTENTIAL FOR IRRIGATION SYSTEM IMPROVEMENT

The physical potential exists to improve nearly all irrigation systems in the basin. This can often be accomplished best by a total system approach on a group project basis. Delivery systems can be upgraded by the installation of more efficient and flood resistant diversion structures; division, control, and metering structures; and canal consolidation, relocation rehabilitation, and lining.

Table VII-4 lists estimates of average present efficiencies of irrigation water use for various portions of irrigation systems. Ditch lining and land leveling can increase on-farm irrigation efficiency as much as 30 percent if properly designed. Properly managed and constructed furrows and corrugations can increase field application efficiencies to 70 percent. Level and graded borders and sprinklers can increase field efficiency to 80 percent with proper management. Conversion to sprinkler irrigation systems has the greatest potential in areas where soils and climatic conditions are conducive to producing the higher valued row crops. Where surface irrigation systems persist, there is potential for recycling

Table VII-3--Potential for wetland improvement through water level control

Location	Total area	Area which can be improved through drainage and agricultural water management	Area requiring improved drainage systems for land improvement	Area which cannot be improved
	acres			
Little Wind-Popo Agie River	4,500	3,820	1,580	680
Riverton irrigated area	37,000	31,450	12,950	5,550
Other Wind River areas	2,500	2,120	880	380
Bighorn River	6,000	5,400	2,100	600
Greybull River & Emblem Bench	31,600	25,280	9,480	6,320
Upper Shoshone River	4,200	3,650	1,340	550
Sage Creek and Lower Shoshone	11,500	10,000	3,680	1,500
Clarks Fork and Little Bighorn	500	440	160	60
Total	97,800	82,160	32,170	15,640

Table VII-4--Estimated existing irrigation system efficiencies

Estimated efficiencies and losses	Type of irrigation: I Large projects	I-II Smaller projects with company ditches	II-IV Individual systems with occasional irrigation	III-IV Individual mountain meadow waterspreading systems
	percent	percent	percent	percent
Delivery efficiency				
Canal efficiency (percent)	65	70	75	75
Farm efficiency (percent)	55	50	40	35
System efficiency $\left(\frac{\text{NIR}}{\text{Diversion}}\right)\%$ 1/	35	35	30	25
Canal losses 2/				
Canal loss (percent of diversion)	35	30	25	25
Canal waste and spill (percent of diversion)	10	10	10	15
Canal seepage (percent of diversion)	25	20	15	10
On-farm losses 2/				
Farm loss (percent of diversion)	30	35	45	50
Surface spill (percent of diversion)	10	15	20	30
Deep percolation (farm ditch & field) (percent of diversion)	20	20	25	20

1/ NIR is net irrigation requirement in a growing season.

2/ Loss is defined here as the portion of the irrigation water supply over which the man-made system loses control. It is not all lost from the surface or groundwater supply.

tailwater through tailwater collection and distribution systems. Most tailwater is of adequate quality for reuse as irrigation water and livestock water. Land smoothing and leveling offer potential doubling of field application efficiencies in some hayland areas which have never been smoothed or leveled.

POTENTIAL FOR RECREATION DEVELOPMENT

There is potential for the development of picnic and camping facilities on private lands, in communities, and in state parks. Well-designed, attractive facilities near well-traveled roads, in scenic areas, and with access to water should provide good returns on private investment and benefit the public by relieving pressure and demand for facilities in national parks, national forests, and public lands. This is likely to be the only way the needed camping facilities can be provided, since public funds for campsite construction are limited. This would release public funds to provide better access and other facilities on public lands. This action would minimize competition between the public and private sectors in providing recreation facilities. Private developers should remember that a poorly designed facility or a facility in the wrong location will not make a profitable return on an investment.

There is also potential for a national or state scenic park or monument in the southwest corner of Bighorn County, the northwest corner of Washakie County, and part of southeastern Park County. The area includes the headwaters of Fifteen Mile Creek, Elk Creek, and Dorsey Creek. This area of about 400 square miles is presently nearly all public land. It is an area of low rainfall, sparse vegetation, and highly colored bluffs, hills, mesas, and plains. It is close to two major access routes to Yellowstone National Park. Since it is at a relatively low elevation, camping is more comfortable early and late in the year than at higher elevation campgrounds and would be usable in all but the coldest winter months. This area could be developed as a staging area campground for visitors to national parks.

While there apparently is no great need for more surface area of lakes and streams for boating in general, there is potential for development of small, lowland lakes, close to towns and roads for use in water skiing. Large bodies of water and streams in the basin have limited usefulness for water skiing. Their waters are too cold much of the year, and long fetch distances for the wind encourage high wave action.

This basin is important locally, regionally, and nationally for its hunting and fishing. The potential exists for improving incomes from hunting and fishing on private lands by improving fish and wildlife habitat, providing facilities for hunters and fishermen, and charging for services provided. Many hunters and fishermen are apparently willing to pay and wait for reservations for improved facilities and services and a better than average hunting or fishing success at a convenient time.

POTENTIAL FOR FISH AND WILDLIFE HABITAT IMPROVEMENT

Fishery

Low streamflows in late season, siltation, undesirable fish populations, infertile water, lack of access, and some pollution, particularly oil field wastes, are factors which limit desirable fish production and fishing in the basin. Table VII-5 lists streams, lakes, and reservoirs where significant potential exists for improvement.

Big game

Big game herds can be increased if additional winter grazing is provided for them. This could be done through range restoration, selected forest thinning erosion control, reduction of livestock grazing, plantings, construction of watering facilities, and fertilization of winter ranges.

Waterfowl

Waterfowl habitat is quite limited in the basin. Reservoirs and lakes are important habitat, but small ponds, reservoirs, and marshlands are extremely important to waterfowl, and these are quite limited in the basin. Since small ponds are also needed for improved livestock grazing management, there is real potential for increasing the number of these small water areas.

Waterfowl habitat can be further improved through increased food supplies and plantings for cover and nesting sites. Table VII-6 lists important areas with potential for waterfowl and big game habitat improvement.

Upland game and other wildlife

Habitat for upland game and other wildlife can be improved in much the same ways as for waterfowl and big game. Food, undisturbed cover areas, and watering facilities can be provided on private and nonprivate lands to increase wildlife numbers.

POTENTIAL FOR LAND TREATMENT AND ADJUSTMENTS

Regardless of the ownership status, there is a potential for improved management practices and conservation measure application on the land not yet adequately treated and on land that will change its principal use. Potential for treatment and adjustments include:

a. Improving cover on cropland, forest, pasture, range, and wildlife lands.

b. Improvement of systems and water management on irrigated lands.

Table VII-5--Streams, lakes, and reservoirs with potential for fishery improvement (land and water required and benefits estimated) Yellowstone Subbasin 1/

Stream, lake, or reservoir	County	Present fishery class	Class change 2/	Acres or miles	Limiting factors	Potential for improvement	Resources needed: Land	Resources needed: Water 3/	Estimated potential annual fisherman-day increase: Use	Estimated potential annual fisherman-day increase: Capacity
Wind River, below Boysen Dam in canyon	Fremont	2	None	2	(1) Low flows	Provide minimum flow for fishery	0	400 cfs (Not consumed)		500
Bull Lk.Cr. - Bull Lake Dam to Wind River			3 to 2	3	Low flows	Provide minimum flow for fishery	0	90 cfs (Not consumed)		3,000
Shoshone R., Buffalo Dam to Heart Mountain Power Plant	Park	2	None	3	Low flows	Provide minimum flow for fishery	0	100 cfs (Not consumed)		1,500
Shoshone River Power Plant to Park Co.line	Park	3	3 to 2	30	(1) Low flows (2) Siltation (3) Pollution (4) Access	(1) Provide minimum flow for fishery (2) Control siltation from irrigated land and from Willwood Diversion Dam flushing (3) Control municipal and industrial pollution particularly oil field wastes (4) Provide access	0	200 cfs		13,500
North Fork-South Fork Shoshone River and tribs. above Buffalo Bill Dam	Park	1 & 3	3 to 2	125	(1) Irrigation diversion fish losses (2) Dewatering stream fisheries (3) Siltation (4) Access (5) Undesirable fish populations	(1) Install fish excluders (2) Supplement or restore more desirable flows below every diversion during irrigation season (3) Reduce siltation of streams by watershed control, particularly from irrigated lands (4) Provide access (5) Renovate and establish improved fish populations	100	4/ (Not consumed)	--	52,600

Table VII-5--Streams, lakes, and reservoirs with potential for fishery improvement (land and water required and benefits estimated) Yellowstone Subbasin 1/ (Continued)

Stream, lake, or reservoir	County	Present fishery class	Class change 2/	Acres or miles	Limiting factors	Potential for improvement	Resources needed: Land	Resources needed: Water 3/	Estimated potential annual fisherman-day increase: Use	Estimated potential annual fisherman-day increase: Capacity
Wind River, Bighorn R., Greybull R.	Fremont Hot Springs Washakie Big Horn Park	4 and 3	No change in class	Approx. 100	(1) Siltation and agricultural pollution (2) Rough fish	(1) Silt control by drainage-wide soil stabilization, with special emphasis on control of irrigation waste and return flows. (2) Install drop structures to control distribution of rough fish	0	0		5,000
Lakes and streams on Beartooth Plateau, Bighorn and Wind R. Mountains including Indian Reservations	Park Fremont	3, 4, and unclassified	4 to 3 and 3 to 2	--	(1) Access facilities, lack of information resulting in unused resources (2) Inaccessibility (3) Empty habitats (4) Stunted fish populations (5) Infertile water (6) Short ice-free season	(1) Roads, trails, campgrounds, signs (2) Maps, information, and education (3) Fish stocking (including rehabilitation) (4) Weed control (5) Fertilization (6) Lake deepening	0	0	--	--
Shell Canal	Big Horn	11	--	--	Diversion fish loss	Fish excluder facilities	0	0		--
Sunshine Canal	Park	--	--	--	" " "	" " "	0	0	(Excluders will prevent wasteful depletions and need for supplemental hatchery trout stocking.)	
N.Fk. Shoshone Ditch	Park	--	--	--	" " "	" " "				
Cody Canal	Park	--	--	--	" " "	" " "	0	0		
Lakeview Canal	Park	--	--	--	" " "	" " "	0	0		
Popo Agie Canals	Fremont	--	--	--	" " "	" " "	0	0		
Small Mountain Streams	Fremont	--	0 to 4	--	(1) "Cemented" gravel bottoms	(1) Stream improvement devices large numbers	0	0		--
Bighorn and Wind River	Big Horn	--			(2) Lack of pools and riffles	(2) Small retention dams to provide sustained or augmented flows (3) Bank erosion structures	0	0	Benefits would include (1) natural survival, (2) natural reproduction, (3) reduce silt loads, (4) reduce stocking required	

1/ Source: Missouri River Basin Interagency Study, July 1971. (Compiled from earlier data.)

2/ The class shown would replace "Present Fishery Class" if measures shown in "Improvement Opportunity" column were fully implemented.

3/ Estimated minimum flows in second-feet in this column are for cold-water fish. They are rough approximations representing about one-third of the average rate of flow of record from U.S. Geological Survey Water Supply papers. Exact flows at any one time would depend partly on other water needs (i.e., irrigation, power). Fish and game interests would be charged only with the difference between minimum flow to be maintained for the fishery and that which would otherwise exist.

4/ The magnitude of flows needed to be passed at each diversion cannot be estimated from available information, but minimum flows required would be equal to one-third of the average flow of record.

Table VII-6--Areas with potential for wildlife improvement, land and water required, and benefits estimated-Yellowstone Subbasin 1/

Resource area	Location or county	Acres involved (gross)	Limiting factors	Potentials for improvement	Resources needed			Estimated annual hunterman-day increase	
					Land acres	Water acres	Total acres	Use	Capacity
Wind River Basin Riverton Project	Fremont	10,000	(1) Waterfowl, migration, production, and wintering habitat in short supply (2) Limited hunting opportunity (3) Waterfowl depredations	(1) 1,500 acres of lake and marsh to be developed in several units under Wyoming Canal and in vicinity of Ocean Lake (2) 3,750 acres/10% irrigable on Cottonwood Bench upland	3,750	1,500 (4,000 a.f. consumed)	5,250 (acquire)		2,500
Oregon Basin	Park	2,000	(1) Waterfowl migration, production, and wintering habitat in short supply (2) Limited hunting opportunity (3) Waterfowl depredations	(1) 1,000 acres of marsh to be developed in 2 or 3 units along inlet canal to Oregon Basin Reservoir (2) Increase size of Oregon Basin Reservoir specifically for waterfowl use (3) Provide upland-game management habitat	3,000	2,000 (3,000 a.f. consumed)	5,000 (acquire)		700 (waterfowl, upland game)
Public lands	Basinwide	10,476,394	(1) Understocking (2) Overstocking (3) Land abuse (4) Watershed degraded (5) Poor wildlife habitat	(1) Range restoration (2) Forest thinning (3) Watershed erosion control (4) Big-game herds balance with carrying capacity (5) Reduction of livestock grazing (6) Pond construction and fencing (7) Fertilization	1,000,000	0	1,000,000		400,000
Watershed projects (PL 566)	Basinwide	12 projects	(1) Lack of public access (2) Small sediment pool and limited depth in reservoir (3) Lack of management (4) Interrupted stream flows (5) Channel alterations and loss of vegetation along watercourses. Increased bank erosion (6) Increasing silt loads in fishing waters through irrigation return flows	(1) Provide right of access to reservoirs; provide roads and trails. (2) Provide "recreation pools" over normal sediment pool storage. Insure minimum depths of 15 feet in over 20% of impoundment (3) Provide for state management. Dams to contain devices to drain sediment pools (4) Maintain stream flows below dams	--	--	--	--	--

Table VII-6--Areas with potential for wildlife improvement, land and water required, and benefits estimated-Yellowstone Subbasin 1/ (Continued)

Resource area	Location or county	Acres involved (gross)	Limiting factors	Potentials for improvement	Resources needed: Land acres	Resources needed: Water acres	Resources needed: Total acres	Estimated annual hunterman-day increase: Use	Estimated annual hunterman-day increase: Capacity
			(7) Loss of habitat from drainage of wetlands created by excess irrigation waters (seepage areas)	(5) Minimize channel modifications; restrict clearing, grazing, and cultivation along streambanks. Replant denuded areas. (6) Reduce silt loads in irrigation return flows (7) Preserve "seepage" areas when these areas comprise valuable game habitat and improved new habitat in structural plans					
Private grazing lands, stock ponds	Basinwide	2,702,651	(1) Waterfowl migration and production habitat in short supply (2) Undeveloped nesting cover (3) Erosion and siltation (4) Livestock tramping	(1) Fencing of existing and new ponds (2) Eliminate grazing and erosion (3) Fish stocking (minor) (4) Seeding and habitat development					
Highway construction	Basinwide	--	(1) Right-of-way fences restrict game movements (2) Degradation of streams through channel alterations and loss of habitat through clearing operations and road routing	(1) Provide underpasses for game where fences are game proof. Adjust wire spacing to reduce entanglement by game jumping fences. (2) Reroute proposed roads; artificially create pools and cover in channeled reaches; restore meanders; modify drainage crossings to create waterfowl marsh or fish ponds, limit clearing.	--	--	--	--	--

1/ Source: Missouri River Basin Interagency Study, July 1971.

c. Protection of land against soil erosion and reduction of floodwater and sediment damages.

d. Changes in land use based on land capability classes.

FOREST LAND DEVELOPMENT POTENTIAL

Potential development for outdoor recreation

The major forest landowners and management agencies have accurate and recent estimates of the potential for recreation development. The Bureau of Land Management and the Forest Service are together responsible for more than half of the land in the basin. These two agencies have developed sites with a current capacity of about 1,660,000 visitor days per year. Another 998,000 visitor days of annual use can be satisfied on potential development sites inventoried.

There is additional potential as well as current development on private land, including the Wind River Indian Reservation, state parks, and other lands, and in Yellowstone National Park. With the additional capacity of undeveloped recreation areas in Yellowstone Park, the national forests, badlands, and other wildland in the public domain, it becomes obvious that the projected demand can easily be satisfied. Some changes in management philosophy will affect the distribution of use but not the capacity. For example, the Wind River Indian Reservation Tribal Council has chosen management activities aimed at reducing public recreation use while providing more opportunity for Indian use. The Forest Service is starting to emphasize recreation development at destination sites while deemphasizing the roadside campgrounds that serve as little more than bedrooms for passing tourists. The latter type of development is felt to be more appropriate for private campgrounds, and they are beginning to emerge as the market expands.

Potential development for timber

Although the theoretical potential for meeting the 2020 demand for timber is present, it is unlikely that the potential will ever be realized. The supply of timber could be roughly doubled by eliminating current losses due to diseases and insects. Realistically, only about half of this could be actually achieved.

It is estimated that intensified forest management, reforestation and regeneration, and new methods of harvesting on stands which are currently inoperable could provide a 50 percent increase in the wood supply.

Timber from land clearing, thinning, and other operations could be utilized more efficiently, and wood processors could improve utilization in their operations. This could provide about a 70 percent increase in harvest efficiency.

These management and utilization potentials are offset by significant

changes in management objectives. The national forest lands, which have produced about 75 percent of the timber in the past, are now managed to emphasize values such as aesthetics, wildlife, and recreation along with timber. Similarly, the forest lands of the Wind River Indian Reservation will be managed exclusively to preserve wildlife and recreation values with a near total exclusion of timber management activities. The effect of this kind of management will be to reduce the supply of available wood below the 1960 production level.

Potential development for forest land grazing

No specific need or unfulfilled demand for grazing has been identified. However, there is a trend toward expanded livestock production. In the future there may be increased pressure on forest range. Before an increase in grazing is allowed, the alternatives should be carefully evaluated. Intensive management and installation of fencing, water facilities, and range revegetation could increase the grazing potential.

Potential development for forest wildlife and fisheries

Most of the forest land is classed as summer range. This habitat can be manipulated and intensively developed to support more wildlife. The treatment would have little effect on wildlife populations, however, since it is lower elevation winter range which is critical.

Most of the fishing needs are satisfied by streams and natural lakes. Stream fisheries can be improved, restored, or enhanced, and additional reservoirs can be developed to provide variety. The physical potential for fisheries development appears sufficient to satisfy projected demands.

Potential development for water management and water quality

The needs for water management can be provided mainly through structural development and other project means. There is a potential for increasing water yield and prolonging water release through snowpack management in forest areas. The Forest Service is conducting research at several locations, and results are promising. However, there has not been enough application to justify extension of research findings from experimental areas to general forest areas. In addition, this basin has constraints on this type of work since most of the high elevation forests are classified as Wilderness or Primitive Areas, and vegetative manipulation is prohibited by Congressional Statute.

The primary water pollutant from forest land is sediment. There is a large potential for land treatment and regulation to reduce the causes of sediment production.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

The U.S. Department of Agriculture has participated in this Wind-Bighorn-Clarks Fork Type IV Study to gather an inventory of potential opportunities to solve water and related land resource problems through USDA programs. With such an inventory, a plan may be developed which can employ the limited USDA resources more efficiently and in such a manner as to solve the most pressing problems first. USDA programs and resources may thus be employed in a coordinated plan to solve the water and related land resource problems in an orderly manner. This chapter discusses identified opportunities for development through USDA programs.

OPPORTUNITIES FOR WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS

The Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended) authorizes USDA technical and financial assistance to local organizations for planning and construction of works of improvement in watersheds of 250,000 acres or less in size. The main purpose of any structure in a project must be either for flood prevention or agricultural water management. Secondary purposes may include recreation, fish and wildlife, municipal and industrial water, or pollution abatement. Project works of improvement usually include land treatment and structural measures. Individual storage structures may not have more than 12,500 acre-feet of floodwater detention capacity or more than 25,000 acre-feet of capacity for all purposes. The installation of structural measures is dependent on the completion of needed treatment on the watershed, and needed land treatment measures must be included in the watershed work plan as a condition for federal assistance.

The watershed map in figure VIII-1 shows the division of the basin into 97 watersheds. Reconnaissance surveys were made of each watershed, and those with significant problems which apparently could be solved through the small watershed project approach were investigated more intensively. Twenty-nine of the 97 watersheds were investigated intensively for project action. These investigations covered 5,000,000 acres, 38 percent of the basin, or 53 percent of the private land in the basin. Where project action was found feasible in the next 10 to 15 years, a watershed investigation report was prepared. Twelve watershed investigation reports were written for 17 of the 29 watersheds investigated. A short description of the potential project developments follows, and table VIII-1 summarizes some of the information available in the watershed investigation reports.

Lower Greybull River Watershed

The Lower Greybull River Watershed is located in Park and Big Horn Counties in the heart of the Wind-Bighorn-Clarks Fork River Basin. There are 202,933 acres in the watershed of which 45,230 are irrigated. The remaining area is primarily rangeland. Fifty-two percent of the land is

federally-owned and administered by the Bureau of Land Management. Forty-four percent is privately-owned and four percent state-owned. There are about 255 operating farm units in the watershed which comprise the Greybull Valley Irrigation District. This watershed includes areas irrigated from the Greybull River within the Dry Creek drainage.

Flood damages have occurred along the entire length of the Greybull River. The most serious damages have occurred in the lower reaches of the Lower Greybull Watershed. Nearly all of the irrigation structures on the river have been severely damaged, destroyed, or bypassed by serious floods. Some croplands have been flooded; others severely eroded beyond restoration. Farmsteads, farm roads and bridges, and nearly all county and state bridges have been destroyed. There is a probability of damaging floods in about 2 of 10 years. Average annual damages are estimated at $50,000. The most serious problems are damages to the irrigation structures in the changing river channel.

The agricultural industry in the watershed is based on the 45,230 acres of irrigated lands. The lands are used to produce forage for livestock, small grains, and row crops. Many of the lands in the watershed have become wet since irrigation has been introduced. Crop production has been abandoned. Wettest areas in the lands are used for low yielding pasture. In other areas crop production is limited and yields reduced. About 31,600 acres are affected by adverse drainage conditions.

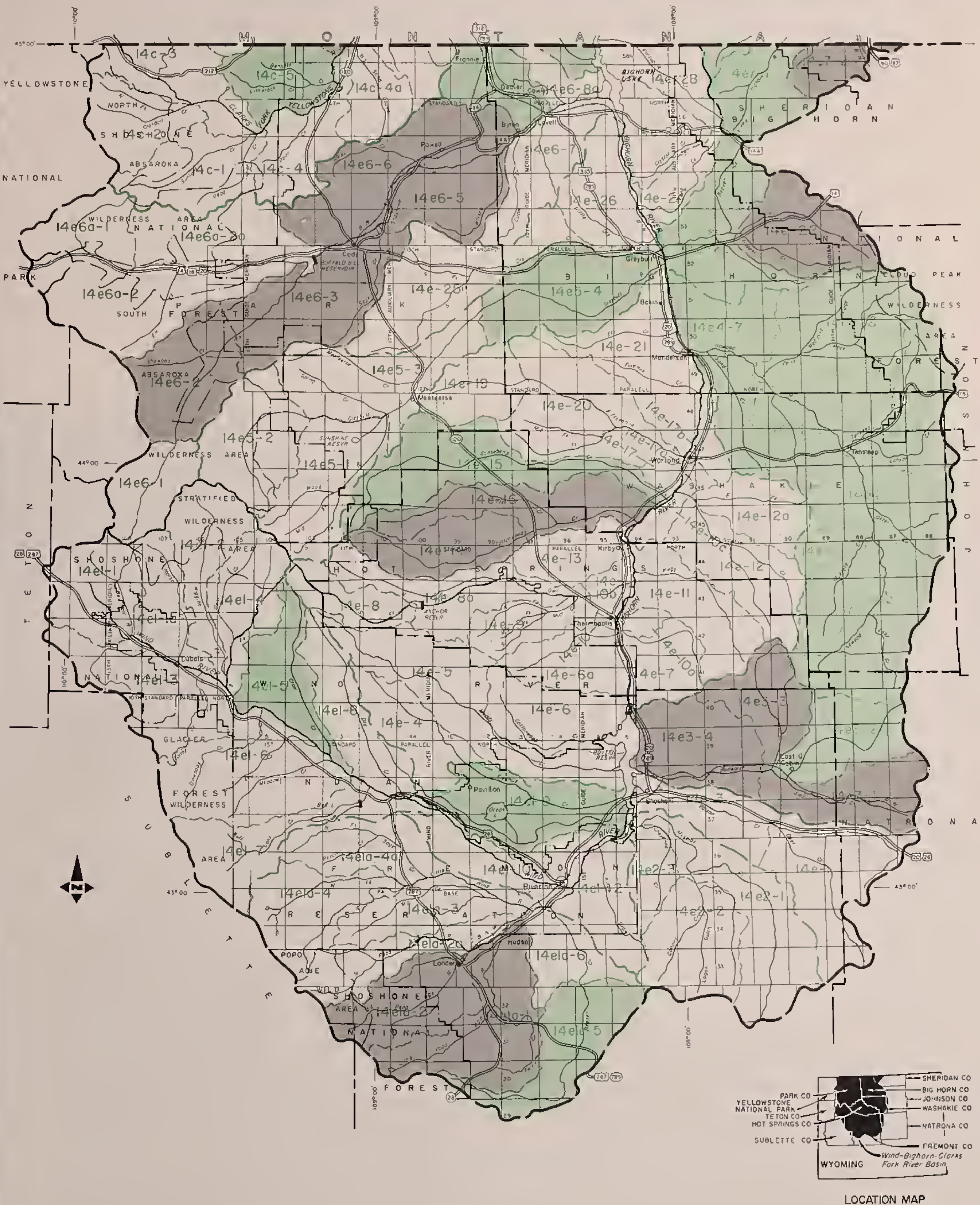
There is little potential for solving the flood problem by construction of floodwater retarding structures on the Greybull River or its tributaries. Reservoir sites which would provide flood control are practically non-existent. Diking and channel improvement have been successfully completed in some places, but are extremely costly.

There is a potential for structural development of a drainage system including both open and closed drains. Two separate systems are proposed which would provide drainage for 21,200 acres of land that is now abandoned, undeveloped, or suffering from decreased production.

Nowood River Watersheds

The Nowood area includes seven watersheds as designated in the Wind-Bighorn-Clarks Fork Study. The area is located in the southeastern portion of the Bighorn Basin. It contains about 1,331,371 acres of which 27 percent is privately-owned; 7 percent state-owned; 50 percent administered by the Bureau of Land Management; and 16 percent within the Bighorn National Forest; and 1 percent are lands withdrawn by the Bureau of Reclamation. There are 20,530 acres of irrigated land; remaining private lands are primarily range and some timber lands.

The primary water-related problem on Nowood River is floodwater and related damages. Floods frequently damage crops, irrigation structures, farm bridges and roads, fences, and urban properties in the town of Manderson. Some flood damages occur almost every year. Average annual



WATERSHEDS INVESTIGATED FOR SMALL PROJECT ACTION

- Watershed investigation report completed
- Detailed field investigation, but no report published
- Field investigation only

FIGURE VIII-1

WATERSHEDS
WIND - BIGHORN - CLARKS FORK RIVER BASIN
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22780H

Table VIII-1--Summary of potential small watershed projects and their impacts, Wind-Bighorn-Clarks Fork River Basin, Wyoming

Watershed number	Watershed name	ECONOMIC IMPACTS: Annual benefits from WIR 1/	ANNUAL BENEFITS: Damage reduction	ANNUAL BENEFITS: Increased production	ANNUAL BENEFITS: External or secondary	COSTS: Total installation cost	COSTS: Annual cost 2/	Benefit to cost ratio (annual)	PHYSICAL AND BIOLOGICAL IMPACTS: Average annual surface water quantity change	Water supply timing improvement	Sediment load reduction	Vegetation improvement	Erosion reduction	Fish and wildlife: Location with improved habitat	Fish and wildlife: Location with reduced habitat	Increased recreational use	People served with new community water supply
		$/yr	$/yr	$/yr	$/yr	$	$/yr	ratio	AF/yr	AF/yr	AF/yr	acres	acres	acres of land or water or miles of stream		visitor days/yr	number
	PRIORITY WATERSHEDS																
14e5-4	Lower Greybull	821,000	0	724,000	97,000	3,900,000	264,580	3.1:1.0	+3,000	0	0	31,600	31,600	10,400 ac.	0 ac.	37,000	0
14e4-1-7	Nowood River Watersheds	200,370	126,970	44,490	28,910	1,627,500	111,220	1.8:1.0	-3,500	13,000	55	3,000	3,000	3,550 ac.	3,560 ac.	-	0
14e-15	Gooseberry Creek	71,000	0	59,000	12,000	832,000	51,400	1.4:1.0	-1,400	3,665	0.25	0	0	175 ac.	175 ac.	-	0
	Subtotal	1,092,370	126,970	827,490	137,910	6,359,500	427,200	2.6:1.0	-1,900	16,665	55.25	34,600	34,600	14,125 ac.	3,735 ac.	37,000	0
	OTHER WATERSHEDS 3/																
14e6-8	Sage Creek-Pryor Mountain	122,180	0	109,180	13,000	1,063,770	65,580	1.9:1.0	-600	1,480	1	0	0	170 ac.	170 ac.	-	0
14e-23	Lower Shell Creek	51,500	0	45,500	6,000	546,900	34,120	1.5:1.0	-1,300	3,370	1	0	0	203 ac.	213 ac.	-	0
14e1-5	Crow Creek near Tiperary	118,230	8,000	94,000	16,230	854,000	52,210	2.3:1.0	-1,600	9,900	1	2,600	2,600	2,845 ac.	2,845 ac.	-	0
14c-5	Cyclone Bar	134,240	0	109,700	24,540	840,000	58,030	2.3:1.0	-1,700	4,950	3	0	0	400 ac.	400 ac.	-	0
14e1a-5	Upper Beaver Creek	109,735	1,600	92,750	15,385	968,800	60,400	1.8:1.0	-1,400	12,900	16	766	766	1,196 ac.	1,196 ac.	-	0
14e-27	Crooked Creek	36,900	0	31,100	5,800	234,500	17,850	2.1:1.0	-3,100	7,000	0	0	0	0	0	-	0
14e3-2	Upper Badwater Creek	39,120	4,085	31,080	3,955	546,000	33,340	1.2:1.0	-400	1,620	1.5	0	0	70 ac.	70 ac.	-	0
14e1-9	Midvale	580,550	0	420,200	160,350	2,490,730	237,250	2.4:1.0	-35,000	0	0	16,830	16,830	16,830 ac.	16,830 ac.	-	0
14e1-9	Hidden Valley	57,400	0	57,160	240	253,500	15,970	3.6:1.0	-300	-	0.6	0	0	28 ac.	28 ac.	-	0
	Subtotal	1,249,855	13,685	990,670	245,500	7,798,200	574,750	2.2:1.0	-45,400	41,220	24.1	20,196	20,196	21,742 ac.	21,752 ac.	-	0
	TOTAL	2,342,225	140,655	1,818,160	383,410	14,157,700	1,001,950	2.3:1.0	-47,300	57,885	79.35	54,796	54,796	25,477 ac.	58,752 ac.	37,000	0

1/ Watershed Investigation Report

2/ Installation cost amortized at 5 5/8 annual percentage rate plus annual operation and maintenance costs.

3/ Some of these watersheds may become priority watersheds.

Watershed number	Watershed name	LAND USE AND AVAILABILITY CHANGES: Rangeland to cropland	Wetland to improved cropland	Cropland to wildlife and recreation land	Rangeland to recreation land	Land to water surface	Cropland with improved production	Rangeland with improved production	Potential for state agency involvement
		acres	acres	acres	acres	acres	acres	acres	
	PRIORITY WATERSHEDS								
	WYOMING								
14e5-4	Lower Greybull	0	10,400	0	0	N/A	31,600	-	Development of Badlands Scenic Area
14e4-1-7	Nowood River Watersheds	3,000	0	0	10	550	0	-	Irrigation and recreation cosponsor
14e-15	Gooseberry Creek	0	0	0	0	175	2,110	-	Transwatershed water development
	Subtotal	3,000	10,400	0	10	725	31,710	-	
	OTHER WATERSHEDS								
	WYOMING								
14e6-8	Sage Creek-Pryor Mountain	0	850	0	0	170	4,850	-	Recreation cosponsor
14e-23	Lower Shell Creek	0	0	0	10	203	1,940	-	Recreation cosponsor
14e1-5	Crow Creek near Tiperary	2,600	0	0	0	245	1,200	-	Irrigation and recreation cosponsor
14c-5	Cyclone Bar	0	0	0	0	400	5,060	-	
14e1a-5	Upper Beaver Creek	766	0	0	0	430	2,034	-	Recreation and wildlife cosponsor
14e-27	Crooked Creek	0	0	0	0	0	1,400	-	
14e3-2	Upper Badwater Creek	0	0	0	0	70	1,700	-	Recreation cosponsor
14e1-9	Midvale	15,580	0	0	0	0	0	-	Irrigation cosponsor
14e1-9	Hidden Valley	0	0	0	0	28	2,362	-	
	Subtotal	18,946	850	0	10	1,546	20,546	-	
	TOTAL	21,94[illegible]	11,[illegible]	0	20	[illegible]	54,256	-	

direct floodwater and sediment damages on the Nowood River above Tensleep are estimated to be about \$19,500. Between Tensleep Creek and Paintrock Creek damages are estimated to be about \$26,500, and from Paintrock Creek to Manderson, \$19,500. Damages in these reaches are primarily to agricultural properties. The U.S. Army Corps of Engineers has estimated average annual damages in the town of Manderson to be about \$39,500. Other relatively slight damages have been experienced along the tributaries of the Nowood. Streambank erosion along the Nowood River damages and destroys arable land, diversion structures, canals, bridges, and other works of improvement. It is estimated that one-tenth of the irrigated land located along the river is subject to this type of damage. About 8.5 acres of cropland are lost annually by streambank erosion.

There is an opportunity to develop a structural program to retard floodwaters, store irrigation water, stabilize streambanks, provide recreational facilities, and enhance fish and wildlife habitat. There are about 290,000 acre-feet of water available for storage sites. Three potential structural projects appear to be feasible and could be developed as small watershed projects. Feasible structural measures consist of (1) a multiple purpose floodwater retarding irrigation storage reservoir on the Nowood River near Big Trails, (2) an extensive program of streambank stabilization along the agricultural lands in the Nowood River flood plain and some of the tributaries, and (3) a system of dikes and levees to protect the town of Manderson from the floodwaters of the Nowood and Big Horn Rivers. The multiple purpose structure could store 6,000 acre-feet of irrigation water and 7,000 acre-feet of floodwater. The irrigation water would be released into the Nowood River as needed and would be diverted for irrigation at various points downstream. The streambank stabilization program would be initiated from the multi-purpose reservoir downstream to Manderson. The areas to be treated would be restricted primarily to channel reaches where active streambank cutting is resulting in loss of valuable irrigated cropland or endangering developments such as roads, irrigation structures, and farmsteads. It is estimated that about 7 bank miles of the Nowood River channel and minor areas on the tributaries need treatment. The localized protection project at Manderson would be similar to that proposed by the U.S. Army Corps of Engineers. A system of levees completely encircling the town would protect it from the floodwaters of the Nowood and Bighorn Rivers.

The multiple purpose reservoir would reduce flood damages below the structure by about \$28,550 annually, and would provide irrigation storage for about 3,000 acres of new lands. The combined average annual benefits would be about \$91,280. The single purpose streambank stabilization program benefits would be about \$22,000 per year. The single purpose flood prevention levee system around the town of Manderson would reduce average annual damages by about \$87,090 per year.

Gooseberry Creek Watershed

The Gooseberry Creek Watershed is located in Hot Springs, Park, and Washakie Counties. It heads in the foothills of the Absaroka Mountain Range

in the southwest portion of the Bighorn Basin, and flows in an easterly direction to its junction with the Bighorn River at Neiber. It contains 232,284 acres, of which 3,820 are irrigated; 27,600 are forested, and the remaining are classified as range with some badlands in the lower parts.

Floods are infrequent in the watershed and cause only minor damages, as there is little development in the flood plain. The most serious water-related problem is the acute shortage of irrigation water. During an average year only 500 acres have a full season irrigation water supply. The soil and climatic conditions along the flood plain are capable of producing 4 to 5 tons of hay per acre. With the short water supply, hay yields are reduced to an average of 1½ tons per acre. About 24,800 acre-feet of water are needed to provide a full supply to presently irrigated lands. Under present conditions only 9,300 acre-feet are available in an average year.

There is no potential for solving the water shortage problem and providing a full-season supply for all existing irrigated land along Gooseberry Creek without importing water or providing large amounts of carryover storage.

There is an opportunity for development of a single purpose off-stream irrigation storage reservoir near the junction of Buffalo Creek and Gooseberry Creek. It would store 3,640 acre-feet of irrigation water and create a pool of about 175 acres. The reservoir would be filled by a diversion of high spring flows from Gooseberry Creek. The diversion structure would direct water into a 2 mile long 100 cfs capacity canal for delivery to the site. Irrigation water would be released from the reservoir as needed to supplement the flows of Gooseberry Creek during the latter part of the growing season.

The structural program would have very little or no effect on the floodwater and streambank erosion problems. The single purpose irrigation reservoir would provide an increased supply for 2,610 acres. All crop yields would be increased to near maximum during the years when a full season supply is available. It is expected that during short years available water would be used for selected areas and alfalfa establishment. Shortages would be reflected in average yields of hay and pasture. Net income per acre would increase by about $28. As many as 22 farmers could be affected by the project. Installation costs are estimated to be about $832,000. Average annual costs would be about $50,380. Average annual benefits would be about $71,000, and the benefit-cost ratio 1.4 to 1.

There also may be an opportunity to purchase up to 8,000 acre-feet of storage from the Lower Sunshine Reservoir and import it into Gooseberry Creek. This would assure a more complete supply to irrigated lands along Gooseberry Creek. Water would be diverted out of the Wood River into a 14 mile canal over the divide to Gooseberry Creek. Purchased water would be released into the Greybull River to equal the diversion rate. Flows in the Wood River appear to be adequate to sustain the Wood River irrigation requirements and to allow for diversion to Gooseberry Creek. The development

of transfer water by this means is outside the authority of the Small Watershed Program of the Department of Agriculture, but may qualify for assistance as a project measure of the Bighorn Basin RC&D Project.

Sage Creek-Pryor Mountain Watershed

This watershed is located in south central Montana and in north central Wyoming. It lies in Big Horn and Park Counties in Wyoming and Big Horn and Carbon Counties in Montana. There are about 393 square miles of drainage within the boundaries of the watershed with 235 square miles in Montana and 158 square miles in Wyoming. Ten percent of the watershed is irrigated farmland with the remaining 90 percent woodland, dry cropland, and native rangeland.

The major water-related problem in the watershed is the lack of adequate irrigation water during peak use periods of July and early August. The original Frannie Division irrigation project design was for approximately 14,600 acres. However, due to water shortages and irrigation inefficiencies, effective water supplies are not adequate to fully supply the 12,800 acres currently under irrigation. Inadequate drainage within the irrigated area has brought about salting problems. A third water-related problem is streambank erosion along Sage Creek and Polecat Creek within the irrigated land area.

A structural program could be developed to help solve the irrigation water shortage problem. Water could be diverted from the Frannie Irrigation Canal early in the irrigation season to an off-channel storage reservoir. A reservoir site 25 feet high with a capacity of 1,500 acre-feet has been identified about 5½ miles northeast of Deaver, Wyoming. Water then could be released from this reservoir during peak water use periods to supplement present irrigation water-short areas.

A land treatment program could be developed for the treatment of the salting problem. Irrigation water management would be the main feature of this program. Water management would include ditch lining to reduce seepage losses and increase delivery efficiencies; installation of water measuring devices to achieve improved water application; installation of tile drains to aid in reclaiming some of the wet, seepy areas; and reestablishing grass on some of the steep land that is presently being irrigated. Effective drainage through the installation of tile drains could be developed on 852 acres.

No feasible alternatives were identified to solve the streambank erosion problem. Proper irrigation water management would help reduce the erosion problem within the irrigated area.

Lower Shell Creek Watershed

The Lower Shell Creek Watershed is located in Big Horn County in the northeast part of the Bighorn Basin. The watershed has a total area of 204,547 acres and consists of Lower Shell Creek and its tributaries from

the town of Shell to its confluence with the Bighorn River near Greybull. About 10 percent of the watershed is forested, 5 percent is irrigated farmland, and the remaining 85 percent is rangeland and badlands.

The water-related problems in the watershed are floodwater damages, streambank erosion, and a shortage of irrigation water supply. The most serious water-related problem is the lack of early spring and fall irrigation water on lands for which no supplemental water is stored. The growing season begins in early May with moisture provided by snowmelt and rain. Irrigation water dependent upon snowmelt from the high mountain areas is not available until early June and is depleted by mid-July. Consequently, the crop yields are below that which could be produced. Hay, for example, yields about 2 ton less than what could be produced with a full water supply.

Lands which are affected in this manner are located along Horse Creek, Beaver Creek, and the lower extension of the Shell Canal. There are 380 acres of irrigated land on Horse Creek, all of which are short of water during the early spring and fall. There are eight operators on Beaver Creek who farm about 1,886 acres of irrigated land; about 660 of those acres are short of water in the early spring and in the fall. There are about 7,240 acres of land irrigated out of canals on lower Shell Creek. About 1,280 acres of late water-right land are serviced out of the Shell Canal extension. Water shortages occur to those lands in the early spring and late fall.

A structural program could be developed to help solve the irrigation water shortage problem. Water is plentiful during the late spring and early summer, but sufficient flows to meet requirements are lacking during much of the irrigation season. The average annual yield of Shell Creek is about 120,000 acre-feet, far in excess of the irrigation requirements. Good storage sites are scarce because of geologic and topographic conditions.

There is an opportunity to develop two single-purpose off-channel reservoirs for storage of irrigation water needs. An irrigation reservoir site with potential for storage of water for Beaver Creek irrigators is located in the Coyote Basin area between Beaver Creek and Red Canyon Creek. A diversion and canal from Beaver Creek would be utilized to fill the reservoir during periods of excess flow on Beaver Creek. Water for irrigation would be released into the draw for conveyance back to Beaver Creek as needed. A potential irrigation storage site for the Shell Canal area is located in the Poverty Flats area below the Shell Canal. The dam site is located in Scharen Draw. An embankment 40 feet high would store 2,000 acre-feet of irrigation water. The site has no appreciable yield from its drainage area and could be filled by releases from the Shell Canal during the irrigation off-season.

Crow Creek Watershed

The watershed lies to the north of the Wind River and is totally within the Wind River Indian Reservation. It contains 118,008 acres,

of which 2,606 are irrigated. There are about a dozen ranches in the entirely rural watershed.

The primary water and related land resource problems are floodwater damages and a shortage of irrigation water in the later summer and fall months. Floods cause an estimated $9,750 annual damage to irrigated cropland, irrigation structures, farmsteads, and other agricultural properties. Heavy sediment loads are deposited into the Wind River from Crow Creek and Sand Draw, causing damages to aquatic life and downstream water users. About 1,975 acres of land are irrigated from Crow Creek and are in short supply of water after mid-July. Average hay yields on those lands are only about 1 ton compared to 3 tons in similar areas with full water supply.

The opportunity exists to install a multi-purpose storage reservoir near Tipperary with about 10,000 acre-feet of storage. About 5,900 acre-feet could be used for irrigation to provide a full supply to 1,200 acres of presently irrigated and 2,600 acres of new lands. The remaining storage would retard flood flows and store sediment accumulation.

Cyclone Bar Watershed

This watershed is located in Park County in northwestern Wyoming with a small area in Carbon County, Montana. The watershed has a total area of 120,884 acres, of which 25,847 are private lands on approximately 21 operating units. Each unit has an average of 160 acres of irrigated land. About 72 percent of the watershed is used for grazing purposes, 25 percent is forested, and the remaining 3 percent is farm land. The water-related problems in the watershed include a shortage of irrigation water, flood damages to diversion and ditch structures on the tributaries, and severe winter icing on Littlerock and Bennett Creeks. The shortage of irrigation water during the early and latter part of the irrigation season is the primary problem. All of the irrigated land on the west side of the Clarks Fork River receives its supply from the small tributaries with the exception of a parcel at the mouth of Line Creek, which receives supplemental water pumped from the river. The drainage area of these tributaries is the high plateau area where snowmelt occurs in June and July and rapidly diminishes in the late summer. The irrigable land is quite gravelly with low water-holding capacity and should be irrigated with small applications at frequent intervals.

There is little potential for solving the water shortage and flood damage problems through reservoir storage on the small tributaries. Good reservoir sites are not available because of topography and the scarcity of suitable construction material. The water shortage problem could be solved by supplementing the flows of the tributary streams with water diverted from the Clarks Fork River.

There exists a potential to install a diversion canal from the Clarks Fork River in conjunction with a storage reservoir that will supplement the flows of Littlerock and Bennett Creeks. This system would provide a full supply 8 years out of 10 for 1,870 acres which are now irrigated

and 3,190 of nonirrigated grasslands below the canal. In addition, 206 acres of existing irrigated land above the canal would be assured a full supply because of reduced demand downstream.

Upper Beaver Creek Watershed

This watershed is located in southern Fremont County. The drainage heads in the Wind River Mountains near Atlantic City and empties into the Little Wind River south of Riverton. The watershed is about 12 miles wide and 40 miles long. Five operating ranches are headquartered near the creek. There are 180,744 acres in the watershed of which 22 percent are privately-owned and 68 percent administered by the Bureau of Land Management. About 1 percent of the land is used for cropland, 2 percent for forest, and the remaining is rangeland. The cropland is used to produce hay and pasture for ranching operations.

Floodwater and sediment damages in the watershed are relatively low. Some flooding occurred above U.S. Highway 287 causing damage to crops and other agricultural properties including canals, fences, and irrigation structures. The sediment produced in the watershed is deposited by the Wind River into Boysen Reservoir reducing its storage capacity and damaging wildlife habitat in the river. Average annual flood damages are estimated to be about \$500 and sediment damages about \$1,100.

The primary problem is a lack of irrigation water during the summer and fall. Beaver Creek is a snowmelt stream, having high flows in the early spring with very low flows during the summer and fall. There are about 940 acres in scattered tracts along the creek which are presently irrigated by direct flows. Because of the short water supply, yields are about one-third of their potential. Ranchers have indicated they intend to irrigate 297 additional acres along the creek. These lands will also receive only a short season supply. The lower two ranches have had to rely almost entirely on dryland hay for winter feed because of the lack of irrigation water. Yields on these lands range from .75 ton per acre during good years to no hay production in poor years, or an average of about one-half ton.

There is an opportunity to develop storage for supplemental water. There is sufficient water available to irrigate about 2,800 acres with a reliable supply. Upstream runoff is of good quality, but becomes polluted with sediment as it moves into the lower watershed.

A multi-purpose dam could be constructed which would store 9,400 acre-feet of irrigation water. Associated storage capacity of 1,600 acre-feet for sediment and 3,500 acre-feet for floodwater would insure the needed storage capacity and protect the structure from floodwaters. The water stored in the irrigation reservoir would be released into Beaver Creek as needed and would flow in the existing creek bed to where it could be diverted into an enlarged and extended Samuel P. Large Canal. The canal presently serves about 630 acres of land along Beaver Creek, and the extension could provide irrigation water for about an additional 2,650 acres.

Crooked Creek Watershed

The Crooked Creek Watershed is located in north central Wyoming and south central Montana. About one-fifth of the watershed lies in Big Horn County, Wyoming, and four-fifths in Carbon County, Montana. There are 84,546 acres in the watershed, of which 90 percent is native range, 9 percent forested, and 1 percent irrigated cropland. The forest land is located within the Custer National Forest and the Bighorn Canyon National Recreation Area. The irrigated area is located along the lower 8 miles of the Crooked Creek flood plain where six operating units carry on livestock-ranch enterprises. About 160 acres are irrigated on Gypsum Creek and a like number from Sykes Spring near Bighorn Reservoir.

The primary water-related problem in the watershed is the annual late season shortage of irrigation water. The watershed is located in one of the drier areas of the basin. After spring rains and snowmelt runoff from the Pryor Mountains, streamflows diminish rapidly to the small yields of springs in the area. An area of high water loss in Upper Crooked Creek further reduces the flows before they reach the irrigated lands. There is a definite need for a firm water supply for the presently irrigated lands and improved water management through rehabilitation of diversion structures and on-farm distribution systems. Approximately 250 acres of previously irrigated land have been abandoned because of the water shortage. There is a need to bring the land back into production to supplement and round out the existing operations.

Floodwater damages within the watershed are limited to the lower areas where overbank flooding occurs approximately every 2 years. Damages are limited to irrigation diversions, fences, roads, and bridges along Crooked Creek. Erosion damages are minor except for exposures of Triassic "Red Beds" in the central part of the watershed and shales in the lower reaches. Sediment from these sources enters Crooked Creek and damages ditches and cropland.

There is an opportunity to develop a firm water supply from an artesian well field by tapping the Madison limestone formation underlying the watershed. This formation underlies the lower watershed at depths of 1,200 to 1,350 feet. This formation is quite cavernous and is considered an excellent aquifer. The potential development calls for the installation of wells to provide a supplemental flow of 29 cfs. The 1,400 acres of irrigable land along Crooked Creek are estimated to require 34 cfs of streamflow during the peak consumptive use period in July. This demand is based on a project efficiency of 45 percent, and can be obtainable with a system rehabilitation and use of return flows in the lower reaches. Assuming streamflows of 5 cfs during this period the peak supplemental requirement is 29 cfs. It is estimated that up to 10 wells may be required. These wells would be installed along the Crooked Creek flood plain in the vicinity of the Montana-Wyoming state line. The flows of these wells will be regulated to discharge the irrigation supplemental requirement into the Crooked Creek stream channel for conveyance downstream to the individual diversion structures and supply about 1,150 acres of presently irrigated land and 250 acres of formerly irrigated land.

Upper Badwater Creek Watershed

The Upper Badwater Watershed is located in Fremont and Natrona Counties. The watershed is in the extreme northeastern part of the Wind River Subbasin at the headwaters of the Badwater Creek. Major drainages within the watershed are Sioux Creek in the upper portion of Badwater Creek, Dry Badwater Creek, and Clear Creek. There are about six ranches along Badwater Creek and its tributaries.

There are 133,843 acres in Upper Badwater Watershed, of which 42 percent are privately-owned; 11 percent state-owned; and 47 percent are federal lands administered by the Bureau of Land Management. There are about 1,730 acres of irrigated hay and pasture land. Approximately 10 percent of the watershed is forested, and the remaining acres are utilized as dry pasture and rangeland.

Floodwater damages in the watershed are primarily to agricultural properties along Badwater Creek below Sioux Creek. The damage is mostly to irrigated hayland and occurs almost annually due to heavy summer thunderstorms. Average annual flood damage in the watershed is estimated to be about $1,430. Average annual sediment and erosion damage is estimated to be about $6,250 from streambank erosion and sediment deposited in Boysen Reservoir.

The lack of a full season supply of irrigation water for the irrigated lands is a most critical problem in the watershed. Water rights are recorded for over 4,400 acres of irrigated land, but presently only 1,700 acres in four ranch units are being irrigated. Yields on these 1,700 acres are severely limited by the shortage of water.

There is a potential to install a small dam on Badwater Creek which would store 850 acre-feet of irrigation water. This would prolong the irrigation period for an average of one month on the 1,700 acres of irrigated land between the site and the town of Lysite. Associated storages of 150 acre-feet for sediment, and 770 acre-feet for floodwater would insure the needed capacity to protect the structure from floodwaters.

Midvale Watershed

The Midvale Watershed is located in Fremont County north of Riverton. There are 180,542 acres in the watershed, of which 59,710 are irrigated on 250 farm units. The watershed includes all of the Riverton Reclamation Project except the North Portal and Cottonwood Bench areas of the Third Division and the Hidden Valley area near Boysen Reservoir. The reclamation project has evolved through a series of stop-and-go decisions since it was started shortly after the turn of the century. All potentially irrigable lands in the watershed have not been developed by the reclamation project.

There is an opportunity to develop additional lands for irrigated crops in the watershed. Some of these lands (Airport Bench and the Big Ridge area) are above the existing canal. Another area (Muddy Ridge) was

originally included in the Third Division, but was never developed. Water could be delivered to the Big Ridge and Airport Bench areas by pumping through an underground delivery system from the Pilot Canal to irrigate about 4,880 acres on Airport Bench and 1,950 acres on Big Ridge. A third system could be developed for delivery of irrigation water to about 8,750 acres on Muddy Ridge.

The development of the additional 15,580 acres would provide an equivalent of an additional 60 acres to each of the existing units for farm expansion. Primary benefits would be about $27 per acre. Total annual benefits would be about $580,550. Installation cost would be about $2,490,730, annual costs $234,530, and the benefit-cost ratio 2.5 to 1. There is a legal complication for this watershed project regarding that part of the land to be irrigated which is presently withdrawn for a reclamation project.

Hidden Valley Watershed

This project is located in Fremont County, north of Riverton, and west of Shoshoni near the southern end of Boysen Reservoir. It is located within the boundaries of the Midvale Watershed described above but is listed here because it can be developed as a separate project. The total project area contains about 7,100 acres. About 2,360 acres are irrigated croplands served by the Pilot Extension Canal of the Riverton Reclamation Project. These lands are periodically short of needed water supplies because of fluctuations in deliveries, particularly as these are associated with rainy periods during the growing season.

Water management can be improved and water shortages reduced if a small reservoir is constructed as a part of the irrigation water delivery system. This reservoir should contain about 200 acre-feet and would cost about $253,500.

Economic impact of installing these projects

Installation of works of improvement can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate task, if not impossible, to quantify all of the effects likely to occur. The basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) the basic group which includes agriculture, forestry, manufacturing and mining which produce goods and services locally for consumption mainly outside the basin; and (2) the derivative or service-oriented group which includes those whose goods and services are mainly

consumed locally. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a sort of chain recreation in motion that is reflected through all sectors of the economy.

A ratio of basic activity to derivative activity is computed from employment data as reported in U.S. Census of Population. This ratio is not static. The number of employees in the derivative group becomes larger relative to the basic group over long periods of time. Employment data from chapter III are combined to show the following:

	Employment			
Year	Total	Basic	Derivative	B/D Ratio
1940	15,953	8,765	7,188	1:0.82
1950	22,001	9,167	12,834	1:1.40
1960	24,790	9,111	15,679	1:1.72
1970	25,289	8,416	16,873	1:2.00
1980	29,100	8,300	20,800	1:2.50
2000	37,700	8,100	29,600	1:3.65
2020	47,900	7,800	40,100	1:5.14

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 85,000 acres in the watersheds investigated will be affected. Changes in land use are expected on onlv part of the total; however, nearly all of the benefited area will be used more intensively and efficiently. Hay, silage, feed grain, and sugarbeet production will be increased while range and native pasture production will decline.

By the year 2000, with the resource developments in place and operative, the gross value of agricultural production will be increased $4,076,000. Approximately 43 percent of the increase ($1,735,000) will come from lands that are irrigated at the present time but need either additional water or drainage. Supplemental irrigation water will be provided by the projects. The remaining 57 percent ($2,341,000) will come from land that is currently used for grazing but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the basin and will contribute to economic development objectives. To the extent that

additional agricultural production and associated economic activity merely displaces production and activity in other areas or affects market prices, the benefits may not truly be national gains. Therefore, it is assumed that output increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of agricultural production per agricultural employee in 2000 is estimated at $29,700 1/. If it is assumed that agricultural labor resources are fully employed without the plan, the additional output will result in 137 additional basic employees. By applying the employment multiplier, it can be shown that derivative employment will increase by 500. The total impact on employment resulting from the increase in agricultural production associated with the programs is estimated to be an increase of 637 jobs. This is comparable to providing employment for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $260 net income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $1.5 million) can be considered as income to the basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the basin and, in turn, respent within the area until its marginal effect becomes zero. A summation of these successive rounds of spending is commonly called the income multiplier. This approach measures the total change in income in the basin resulting from the initial change in income from a particular sector. Recent studies in areas with an economy similar to Wind-Bighorn-Clarks Fork Basin estimate the income multiplier to be from 2.00 to 2.18. If the entire $1.5 million were dispersed in the basin, the total income effect would be at least $3 million annually, which is an average of $31 for each resident. No attempt was made to project the income multiplier for the year 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of installation costs and part of the project administration (construction inspection) costs for watersheds investigated in this study total $6,558,000. If a 15-year period is required for project installation and federal funds are provided in equal increments, this is equivalent to $437,200 annually. All of this investment can represent new income to the study area provided that a local contractor is employed and he purchases capital, labor, supplies,

1/ Gross value of agricultural production from table III-15 ($71,182,000) divided by the number of agricultural employees from table III-10 (2,400).

and machinery within the study area. The local economy could be enriched as much as $875,000 annually because the added increment of new income during the construction period is altered by the income multiplier.

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT OPPORTUNITIES

The basin area is included in a resource conservation and development (RC&D) project. A basic objective of the RC&D program is the orderly development, improvement, conservation, and utilization of natural resources of the area, thereby providing employment and other opportunities to the people of the area. The RC&D program is applicable where the acceleration of current land treatment and structural conservation activities, plus use of other authorities, will provide additional opportunities for the people.

A preliminary survey shows there are many diverse opportunities for RC&D project action through the potential of accelerated technical help and financial assistance. There are about 400 group irrigation systems needing improvements that could qualify for the project type action. Also, it is estimated there are about 170 group farm drainage projects which could qualify.

Problems with community, domestic, municipal, industrial water, and sewage disposal systems in some parts of the basin area may be reduced through project action. Other possibilities include various community recreation developments.

DEVELOPMENT OF A LAND TREATMENT PROGRAM

The concern for the proper use and management of land and related vegetative and water resources has been a primary reason for the existence of U.S. Department of Agriculture agencies since they were first created. The widespread practices of contour stripcropping, farm lot windbreaks, land terracing, gully plugs, selective forest cutting, and other such practices indicate a remarkable success in advancing the cause of proper land use in America. Nevertheless, much remains to be done before every acre of land is used according to its capabilities and treated according to its needs. Some of the practical opportunities for this basin are described in this section.

Land treatment for nonfederal lands

Proper and improved land treatment on private lands and leased state lands is the basic concern of the Soil Conservation Service in the U.S. Department of Agriculture. Proper land treatment is the basic element of small watershed projects. In order for a watershed project to qualify for a high priority, the needed land treatment measures must either be on the land or local people are ready, willing, and able to install most of them within a reasonable project installation period. Needed land treatment

measures, regardless of ownership, must be included in a watershed work plan as a condition for federal assistance. Acceleration of technical and financial assistance in developing land treatment measures can be provided to approved watershed project areas.

The conservation operations program of the Soil Conservation Service is an ongoing program of assisting land owners by providing technical assistance and advice in soil and water conservation in accordance with priorities and programs of local conservation districts. There is an opportunity to accelerate the application of land treatment practices through this program as conservation districts act to assign priorities and promote the development of these practices.

The Bighorn Basin Resource Conservation and Development Project (RC&D) is now in the operations stage. Funds available through this program will make possible accelerated technical services for soil surveys, conservation planning, and application assistance within approved specific project measure areas.

Currently 1,840,453 acres, or 36 percent, of the 5,115,210 acres of state and private lands in the basin are adequately treated. With the continuation of the existing rate of ongoing application, an additional 511,250 acres, or a total of 46 percent, of state and private lands will be adequately treated by the year 2000. The total installation cost to achieve this degree of treatment is estimated to be $35,173,000. The forage equivalent increase for this output is estimated to be 289,240 AUM's per year

If the rate of application is accelerated to almost double the existing ongoing rate, an additional 956,220 acres of state and private lands would be adequately treated by the year 2000. This would increase the total area treated to about 55 percent. The installation cost for this amount of treatment would be $52,400,000 with the forage equivalent increase for this output estimated to be 432,670 AUM's per year.

Table VIII-2 presents a detailed analysis of the economic effects for each of the major land use areas in the basin for both the ongoing program and the proposed accelerated program. A study of this table shows that the best rate of return per AUM for land treatment investment will be on rangeland. On state and private rangeland, treatments costing $2.63 per acre can increase the average annual forage yield from 0.26 to 0.38 AUM's per acre.

Although rangeland provides the best rate of return for land treatment investment, the major portion of the proposed annual forage equivalent increase will occur from land treatment measures which are installed on irrigated cropland. This production increase has been estimated to be over 2 AUM's per acre. In addition to the production effects, the proposed treatment measures for the irrigated cropland will improve irrigation efficiencies, control erosion, improve water quality, and reduce operation and maintenance costs.

Table VIII-2--Economic effects of projected land treatment alternatives on state and private lands

Land use and treatment practice	Area needing land treatment	Projected Existing Programs			Proposed Accelerated Programs		
		Applied by: year 2000	Installed cost	Annual forage equiv. incr. 1/	Applied by year 2000	Installed cost	Annual forage equiv. incr. 1/
	---acres---	--acres--	--dollars--	---AUM's---	---acres---	--dollars--	---AUM's---
Irrigated Cropland							
Irrigation and/or drainage systems	217,240	54,310		168,700	76,030		236,200
Water and cultural management	159,940	39,980		70,000	55,980		98,000
Cultural management only	53,830	18,840		4,700	26,920		6,700
Subtotal	431,010	113,130	34,000,000	243,400	158,930	50,000,000	340,900
Nonirrigated Cropland							
Erosion control	2,283	460		340	1,030		770
Soil maintenance and improvement	554	140		110	280		210
Subtotal	2,837	600	33,000	450	1,310	70,000	980
Range and Dry Pasture							
Planned grazing systems	2,156,810	323,520		32,350	647,040		64,700
Brush and weed control	555,600	55,560		11,110	111,120		22,220
Reseeding	7,400	740		370	1,480		740
Range renovation	13,890	690		350	1,390		700
Subtotal	2,733,700	380,510	1,000,000	44,180	761,030	2,000,000	88,360
Forested Land							
Forage improvement	80,970	12,140		1,210	24,290		2,430
Reduction of grazing	7,640	1,150		0	2,290		0
Subtotal	88,610	13,290	40,000	1,210	26,580	80,000	2,430
Other Lands							
Revegetation	18,600	3,720	100,000	NA	8,370	250,000	NA
TOTALS	3,274,757	511,250	35,173,000	289,240	956,220	52,400,000	432,670

Price base 1974. NA = Not Applicable

1/ All crop and forage production converted to AUM's of forage equivalents (i.e. 450 pounds of corn or 900 pound hog = 1 AUM).

Opportunities for national forest development and multiple use programs

Development

The discussion of potential forest development in Chapter VII indicates there is ample opportunity for accelerated development on national forest land. The implicit assumptions underlying the identification of potentials and of problems and needs are that the region will continue to supply forest-related goods and services at a rate equal to that of the immediate past. This is roughly analogous to the National Economic Development Objective described in the Water Resources Council Principles and Standards, and is the traditional Type IV River Basin approach.

The opportunities for development to help meet projections of demand for timber, recreation at developed sites, forage, and fish and wildlife are shown in table VIII-3. Accelerated early action is an opportunity on the four potential small watershed projects listed earlier in this chapter which include national forest lands. Forest Service development could be accelerated in conjunction with PL-566 projects on these areas if sufficient additional funds such as Water Resource Development and Related Activity Program (WRDRA) money is provided. National Forest development programs and projects could be accelerated to include almost all the remaining opportunity. Additional funds and manpower would be essential to convert these opportunities to reality.

In order to fully appraise the impact of Forest Service programs an alternative set of assumptions and opportunities has been identified. The alternative is roughly analogous to an Environmental Quality Objective and is very consistent with a broad management direction which emphasizes key values such as dispersed recreation, wildlife, natural beauty, and watershed protection. Development is not an important feature of this alternative, and much of the forest area is reserved formally as Wilderness or by management direction as nondeveloped area.

There is good opportunity to emphasize the key values of this "nondevelopment alternative." As previously mentioned, the Wyoming portion of the basin contains 1,345,800 acres of national forest land classified as either wilderness or primitive area. In addition, there is about 708,000 acres of roadless area (about 42 percent of the nonclassified national forest land) which provides substantial opportunity for dispersed recreation and retention of natural and wild characteristics.

Impacts

Complete implementation of development opportunities would have significant positive impacts on future timber supplies, future minerals production, future recreation opportunity, future livestock production, and future wildlife numbers. Concurrently, some negative impacts would occur, notably in future opportunity for primitive and unconfined recreation and wilderness type experiences. Development could have some adverse

Table VIII-3--Comparison of land treatment and structural measures planned and opportunities for an accelerated development alternative, Bighorn and Shoshone National Forests, Wyoming, 1970

Project Item	Unit	Estimate Unit Cost	Currently Planned	Development Alternative Opportunities	
				Potential PL-566 action	Other long range action
		---dollars-----			
Range revegetation & plant control	acres	10-20	14,600	2,200	19,800
Range distribution trails	miles	200-600	160	3	127
Range fences	miles	2000-2500	355	30	240
Forest planting or seeding	acres	220	5,400	100	900
Forest Management:					
Insect control	acres	25-250	700	500	4,300
Disease control	acres	5-70	0	3,400	30,600
Release, harvest, thinning, weeding	acres	30-70	23,100	1,900	17,300
Fishing stream improvement	miles	200-2000	40	40	780
Fishing lake improvement	acres	3000-10,000	200	360	4,190
Waterfowl habitat management	acres	400-600	0	5	20
Fence key wildlife areas	miles	2,500-3000	10	NA	25
Trail construction & improvement	miles	5000-8000	1,300	40	360
Road construction & improvement	miles	35,000	1,370	55	315
Roadside observation sites	each	5000	10	5	25
Erosion control:					
Gullies	miles	2500-5000	5	1.5	119.5
Sheet erosion	acres	100-1000	0	5	4,095
Abandoned roads & trails	miles	500-1000	0	0.5	260
Stream bank stabilization	miles	200-2000	0	2	28
Mining control & restoration	acres	100-500	0	5	20
Sediment basin construction	ac.ft.	5000	0	0	5
Recreation:					
New site development					
Camping - picnicking	sites	2,500	0	0	146
Boat launch	sites	15,000	0	0	8
Winter sports 1/	sites	200,000	0	0	7
Wildlife habitat management	acres	15-50	1,500	NA	10,200

1/ Does not include private investment.

impacts on landscape beauty, water quality, air quality, and the opportunity for special interest items such as scientific study.

Selection of the nondevelopment alternative would have significant negative effect on future production, especially of commodities such as timber and forage, and on opportunities for developed recreation such as camping, picnicking, summer homes, downhill skiing, and boating. Restrictions on access would eliminate motor vehicle use from many areas with a possible negative impact on grazing use, wildlife habitat development, wildlife harvest, mineral development, and the opportunity for structural water developments. The positive impacts would be primarily related to opportunities for primitive and unconfined recreation, solitude, special interest studies, water quality, air quality, and natural landscape beauty.

Table VIII-4 compares some impacts of development and nondevelopment alternatives. In addition, if the development alternative included installation of erosion control measures to the full extent indicated in table VIII-3, the following reductions in soil losses could be expected:

Measures	Annual soil loss reduction
	-----------tons-----------
Gully stabilization and control	38,700
Sheet erosion control	81,100
Stabilization of abandoned roads and trails	13,000
Streambank stabilization	9,300
Restoration and control of mining areas	7,500
Sediment basin construction	10,900
Forest planting and seeding	26,000

State and private forest land development opportunities

There are many opportunities for accelerated development on the state and privately owned forest lands in the basin. There are about 75,000 acres of nonfederal forest land within the project area of the identified potential small watershed projects which have some opportunity for accelerated forest land development. Existing cooperative forestry programs can be accelerated or initiated by employing a District Forester for this

Table VIII-4--Comparison of some impacts of acclerated development and non-development alternatives, national forest land, Wind-Bighorn-Clarks Fork River Basin, Wyoming.

Use, service, or product	Unit	Amount provided: Development alternative	Amount provided: Non-development alternative
Sawtimber and wood products	thousand board feet	107,000	27,000
Livestock capacity	thousand animal unit months	219.4	156.7
Developed recreation			
camping	thousand visitor days	2,000	1,199.7
picnicking		289.8	133.0
boating		96.25	21.25
winter sports		481.2	292.5
Water yield	ave. annual acre feet	3,269,400	3,259,000
Wildlife harvest			
hunting use	thousand visitor days	240	200
fishing use		1,120.5	1,104.6
Dispersed recreation use	thousand visitor days	1,343.6	830
Opportunity for primitive and unconfined recreation, solitude and special interests	qualitative	reduced on about 700,000 acres.	No change
Natural landscape beauty	qualitative	reduced on some portions of area depending upon amount of new annual development.	No change

area as soon as funding is appropriate. Timber harvesting, timber stand cultural measures, insect and disease control, fire control, and reforestation are all measures which could be used to improve timber production from the basin's state and private forest lands. This increased timber can complement the timber output of the national forests and contribute to the projected demand for timber. Table VIII-5 shows the estimated opportunity for accelerated land treatment and management on state and private forest lands.

Table VIII-5--Existing land treatment program and development on state and private forest and rangelands 1/

Item	Amount	
	Existing	Proposed
	------------acres------------	
Forest inventory	20,047	320,253 2/
Timber management		
Accelerated harvesting	130 3/	108,100
Timber stand improvement	0	40,000
Insect and disease control	0	500
Tree planting and seeding	0	1,200
Area under fire prevention and control		
Forested lands only	291,005	340,300
Rangeland	2,890,086	4,170,050
Small watershed project assistance	0	75,000

1/ Rangelands are included here for fire control treatment only. See table VIII-2.

2/ This is primarily private forest land in the basin.

3/ This was on state land. Private harvest areas are unknown.

Source: Correspondence with Wyoming State Forester and Wind River Indian Reservation Forester, U.S. Forest Service Surveys and Wyoming Conservation Needs Inventory.

Development and management of other public lands

The Bureau of Land Management administers the unreserved public lands which have long produced wildlife and fish habitat, timber and other wood products, water recreation, minerals, and grazing for livestock. The bureau has an active program of range and watershed improvement including brush control, contour terraces and furrows, fencing, seeding, water-spreading, detention dams, diversions, stockwater ponds, and spring developments. It also has an active program of recreation site selection and withdrawal. The lands are classified for retention in public ownership or disposal to either private individuals or other government agencies. Some of these lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes, and other lands have been transferred to the Bureau of Reclamation for the purpose of irrigation or electric power development.

USDA cooperation and resource development on private and federal rangelands in the basin is in its beginning stages. This cooperation consists of assisting in the preparation of coordinated ranch and allotment plans and working through conservation districts for both private and federal lands. In ranch planning, all resources pertaining to the successful operation of a ranch are considered, particularly the crop and rangeland resources. When national forest lands are involved, a comprehensive plan involving these lands is considered. Recent plan developments and on-the-ground application of these plans have resulted in much improvement of the lands involved. Future operations will continue to conserve and develop the important public land resources.

RURAL RENEWAL AND DEVELOPMENT OPPORTUNTIES

Secretary's Memorandum No. 1667 provides for the establishment of A USDA Committee for Rural Development in each state. Membership includes representatives of the Forest Service, Soil Conservation Service, Farmers Home Administration, Rural Electrification Administration, the State Cooperative Extension Service, and the Economic Research Service.

The purpose of the committee is to establish liaison with the executive officers of the state government and other appropriate organizations. It is directed to work closely with state and local people in support of comprehensive planning and development. The committee is an important link in the chain of information and technical assistance flowing from the USDA to the people.

Secretary's Memorandum No. 1667 also calls for recognizing that development is the primary responsibility of the local people. Within the basin the organization of the conservation districts, the RC&D project, and other local development groups is a fertile field for carrying out the purposes of the rural development program. Each county in the basin has organized rural development county committees to work with the state committee.

OPPORTUNITIES FOR WILD, SCENIC, AND RECREATION RIVER AREAS

The Wind River has been identified and the Clarks Fork is being considered as having potential as wild, scenic, and recreation river areas that need further study to determine their suitability and availability for inclusion in the National Wild and Scenic River System. The existing features in these two areas are as follows:

The Clarks Fork River originates in southern Montana near Cooke City. It meanders into Wyoming near Pilot and Index Peaks. For the first 20 miles the river flows at a moderate rate through a wide flood plain dotted with ranches and native hay meadows.

At the confluence with Crandall Creek the river drops, literally, into a 20-mile long primitive, scenic, and practically unnegotiable canyon. At the canyon mouth the river flows northward through small ranching communities and finally joins the Yellowstone River near Billings, Montana. Upstream from the canyon mouth the river is mostly in federal ownership--Shoshone National Forest in Wyoming, and Gallatin National Forest in Montana. Downstream from the canyon mouth private ownership and public domain lands are intermingled.

The Clarks Fork River is free-flowing and it traverses an area with unique scenic, recreational, geological, historical, archaeological, fish, and wildlife values. The contrasting faces of the river from a placid, pastoral stream in the upper reaches to the awesome white water rapids, waterfalls, and deep pools in the canyon show little of man's influence. The population of the adjacent area is very small. The town of Cody, Wyoming, 38 miles away, is the largest population center. The Clarks Fork Road parallels about 11 miles of the canyon rim but never approaches closer than three-fourths mile. From the bridge near the Crandall Creek confluence to the Beartooth Highway the river is adjacent to the Clarks Fork Road. From the junction of the Beartooth Highway and the Clarks Fork Road to Cooke City, Montana, the river shares a broad valley bottom with U.S. Highway 212, the Beartooth Highway.

The Clarks Fork River supports a thrifty fish population and provides high quality stream fishing. Most of the tributaries to the river are very productive also. Sunlight, Crandall, and Dead Indian Creeks are rated as very good trout waters with the fisheries of state-wide importance. The Clarks Fork itself is rated as important trout water with the fisheries of regional importance. Black bear, grizzly bear, mule deer, elk, mountain goat, various predators, waterfowl, upland gamebirds, eagles, falcons, and other game and nongame animals are abundant in the canyon and upper river valley.

The area's historical significance stems chiefly from the journey of the Nez Perce Indians under Chief Joseph. The entire band including women and children, successfully eluded the U.S. Army by traveling down Dead Indian Creek, negotiating the face and sheer cliffs of the Clarks Fork Canyon. They emerged at the mouth of the canyon and escaped into central Montana.

There are several proposals for development which could affect the river. The Bureau of Land Management and Bureau of Reclamation have a power withdrawal along the length of the canyon portion. Two dam sites for hydroelectric power production have been proposed. One is in sec. 26, T. 56 N., R. 104 W., and the other is in sec. 10, T. 56 N., R. 105 W. Determination of which use, power production or wild and scenic river designation, has priority for this reach of the river will have to be made. A proposed all-weather highway is located in the canyon, but the location has been disapproved by state officials. The issue is quieted but not dead, as future pressure may be mounted to construct the highway in the canyon if the river is not included in the Wild and Scenic River System.

The Wind River above Boysen Reservoir has been identified for study for inclusion as a recreational river area. However, existing reclamation and irrigation projects significantly affect the flow of water in this section of the river. The Wind-Bighorn River from Boysen Dam to the mouth of Wind River Canyon flows through an area which has particularly unique geologic and scenic values which may also make this reach eligible as a recreational river.

No proposal for USDA action in these reports would significantly adversely affect the designation of any part of the Clarks Fork or Wind River as a part of the National Wild and Scenic River System.

In addition to the Clarks Fork and Wind River, some other streams in the basin that currently have not been identified but might also be studied for designation as a part of the National Wild and Scenic River System are as follows:

Wood River above its reservoir diversions
Greybull River above Pitchfork
North Fork Popo Agie above national forest boundary
Middle Popo Agie above national forest boundary
Medicine Lodge Creek above Hyattville
Paintrock Creek above Hyattville
Little Bighorn River above State Line
South Fork Shoshone River above Valley
North Fork Shoshone River above Buffalo Bill Reservoir
Tensleep Creek above Tensleep

Few of the streams listed above are well suited to recreational use for floating. The use of the Shoshone and Bighorn Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

The State of Wyoming Stream Preservation Committee has proposed legislation to study and classify the streams of the state. Their recommendations will be presented to the legislature for further action.

IX. INTERAGENCY COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

There are project and program opportunities and needs for resource development beyond the scope of existing USDA programs. Some of the opportunities can be developed without USDA action, but most can be enhanced if existing or enlarged USDA programs are included in interagency efforts. Changes in some of the existing programs and agency responsibilities or new programs may be required to best meet some of the needs of the people for the resources of the basin.

Chapter VIII discussed opportunities identified for existing USDA projects and programs. This chapter suggests some alternate approaches, describes some proposed developments and programs of other agencies, discusses the potential for using basin water resources outside the basin, and discusses the need for expanded USDA programs.

ALTERNATIVE APPROACHES

General

Alternative approaches to natural resource development in the basin range through a large number of combinations of USDA, other federal, state, local government, and private programs, projects, and regulation patterns. One possibility is that all organizations decrease and repress resource development. At the other extreme all organizations could choose to accelerate resource development. Neither of these alternatives is likely to occur. Another possibility is that no significant change in programs or rate of development will occur. This is also an unlikely prospect, since increased use of resources is expected both within and outside the river basin; and changes in priorities will affect federal and state programs. For example, the management policies of the National Park Service for areas outside the basin will directly affect opportunities for private and state recreational facilities in the basin.

In the near future, federal financial assistance in water and land resource development will probably decelerate. Technical assistance will probably still be available, and regulations may increase. Therefore, if the resources are to be developed to meet regional needs, state and private interests will probably accelerate. As priorities, needs, and situations change in the future, more federal financial assistance may become available, but any acceleration in federal assistance will most likely require a corresponding acceleration in state and private activity. Those states which become well organized in resource development will stand to benefit most when and if federal financial assistance is increased.

Specific alternatives in small watershed protection projects

Midvale Watershed

The primary opportunity in this watershed is the development of new

irrigated land. It is believed that most of this land is presently public land reserved by the Bureau of Reclamation and leased to private interests as marginal grazing land. Development through USBR programs will probably not occur in the near future nor is it likely to occur through USDA programs because of land ownership, project sponsor, program policy limitations. If early development of this project is desirable, the State of Wyoming and local private interests should investigate the possibility of acquiring the land and water and developing the project.

Cyclone Bar Watershed

Even though land use is not expected to change, this project is designed to irrigate land not presently irrigated. Some of the land is railroad land, and some is public land. Therefore, the same recommendation given above applies to this watershed.

Gooseberry Creek Watershed

The watershed investigation report for this watershed proposes a small reservoir for storage of supplemental irrigation water for presently irrigated lands. These lands would still need additional water. Some water may be available from Wood River through purchase and transport through a new canal. Since this canal could not be constructed in a single cohesive watershed unit, it is not likely that it would be developed under USDA programs. Early development of this project is essential if it is ever to be realized. Local private interests of the State of Wyoming should investigate the possibility of acquiring the water and building the system.

Crow Creek Watershed

This watershed is entirely within the Wind River Reservation and could be developed without USDA assistance. However, USDA assistance is available only if the Indian tribes will form a local sponsoring organization according to federal and state laws as so many other private organizations have done. Otherwise, this development will require other than USDA programs.

<u>Proposed projects of other federal agencies</u>

Bureau of Land Management - Bighorn Basin Project

The Bureau of Land Management has defined program needs in the basin as: (1) improved range management to bring 50 percent of the public range area to "good" range condition and the area now rated as "poor and bad" to "fair" condition for an annual increase of up to 208,000 animal unit months; (2) range and forest fire and insect protection; (3) resource development through contour furrowing, seeding, and sagebrush control to reduce erosion while improving the range; (4) forest management to improve timber yield and enlarge the timber industry; (5) development of new camping and other recreational facilities and upgrading of roads for access to public lands; (6) minerals inventory and development; (7) road construction;

(8) lands classification; and (9) cadastral surveying. An action program has been proposed to meet these needs. 1/

Bureau of Reclamation

a. Riverton Reclamation Project Extension

The original area proposed for the Riverton Project was 106,450 acres of irrigated land. Water is now delivered directly to about 57,000 acres. There are apparently about 14,450 acres of land, most of which is in the Muddy Ridge area of the project for which development has been deferred and which will require future congressional action to complete.

b. Polecat Bench Reclamation Project (Shoshone Extension (North))

This is a proposed extension of the Shoshone Reclamation Project to include 18,000 acres of new irrigated land on Polecat Bench and 1,200 acres in the Frannie Loop area of northeastern Park County in Wyoming. The principal features of the project would be the Polecat and Holden Canals, Holden Dam and Reservoir, two small pumping plants, and distribution and drainage systems. Water would be supplied from the Buffalo Bill Dam through the Heart Mountain Canal. Estimated diversions to the project are 70,000 acre-feet per year. If consumptive and evaporation uses for the project are about 50,000 acre-feet per year, then about 20,000 acre-feet per year would be released from the project in surface and ground-water flows.

Some of this return flow would probably go to Cottonwood Creek, a tributary of the Clarks Fork. The project is multi-purpose in that recreation facilities will be provided, and some fish and wildlife resources will be enhanced.

c. Transbasin diversion from the Wind-Bighorn-Clarks Fork River Basin to the Powder-Tongue Basin for industrial purposes

The Bureau of Reclamation has performed a reconnaissance survey and given options for up to 640,000 acre-feet of water in the Wind-Bighorn-Clarks Fork River Basin to be transported to points in eastern Montana and Wyoming for industrial purposes. One hundred ten thousand acre-feet are to be used on the Crow Indian Reservation. One hundred eighteen thousand acre-feet are to be used in other areas in Montana, and the remainder are to be used in eastern Wyoming.

The 640,000 acre-feet estimated above represent the estimated flow remaining after assumptions were made concerning development on the Wind River Indian Reservation, completion of the Riverton Project, depletions for smaller programs envisioned by other federal agencies, Bighorn Unit, Greybull Flats, Polecat Bench, Shoshone Extension (south), supplementation water to the Greybull Valley, the Hardin Bench Unit, new irrigated lands in the Crow Indian Reservation, completion of

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1/ Wyoming's Bighorn Basin Project, USDI, BLM, Worland District, 1962.

developments at Hanover Bluff and Owl Creek, minimum streamflows for fishery requirements, and minimum flows for maintaining hydroplant capabilities.

There are several alternate project features being investigated. Pipelines up to 144 inches in diameter, up to 214 miles long, up to 30,500 feet of tunnels, several offstream storage sites, and several pumping plants are being considered. Some alternative project features use existing streams with increased flows for part of the transportation system. Costs of delivered water range from $85.00 to $135.00 per acre-foot. Most of the water will be used for coal hydrogenation. Once committed, there would probably not be much return flow. If there is significant return flow, a new pattern of agriculture might result in eastern Wyoming and Montana.

Nothing much has been done to estimate increased municipal water supply needs created by this industrialization, but it is assumed here that this problem will be included in other studies.

d. Modification of Buffalo Bill Dam

Buffalo Bill Dam is believed to be incapable of containing or passing safely the probable flood that might enter the reservoir without overtopping and damaging the structure. Demands on the storage of the reservoir are increasing both for supplemental water to existing irrigated lands and for supplies for new irrigated lands.

The safety of the dam can be assured by increasing the size of its spillway or by increasing the spillway size in less amount and raising the dam. The second alternative would increase usable storage by 181,000 acre-feet over the present storage of 421,320 acre-feet, and would require the relocation of roads and recreation facilities. Fishery, wildlife, and recreation needs have also been considered and might also be met by enlarging Buffalo Bill Dam. Water would be provided for the Oregon Basin Project described below.

This project could provide supplemental water to two early private irrigation projects--the Cody Canal, and through transfer, the Lakeview Irrigation District. A new hydroelectric power plant would replace the existing plant at the dam. There is also a potential for supplying municipal and industrial water for use within the Bighorn Basin.

e. Oregon Basin Project or Shoshone Extensions Unit (South)

This project depends on the enlargement of Buffalo Bill Dam and Reservoir described above. A full supply of water would be supplied to 17,270 acres of irrigable land. The principal project features would include the Oregon Basin Feeder Canal and an Oregon Basin Reservoir which would not require a dam. Two other canals have been

anticipated. The Dry Creek Canal is to be supplied from the reservoir, and the YU Canal was to be supplied from the Greybull River with water from the old Sunshine Reservoir. However, a new reservoir has been constructed recently on the Greybull system which may require changes in the plan for the Oregon Basin Project.

f. Clarks Fork Division in Wyoming

The Bureau of Reclamation's plan for development of land and water in the Clarks Fork Basin in Wyoming includes three dams and reservoirs on the main stem (Hunter Mountain, Thief Creek, and Bald Ridge) and a dam and reservoir on Sunlight Creek. These would provide water for three hydroelectric power plants and storage water for the full irrigation of 1,600 acres of irrigable land. This land is called the Badger Basin Unit and would obtain water from the river through pumping. The irrigation project is considered feasible, but the power production was not considered feasible at 3 percent interest rates by 1957 standards of justification. However, power production is considered essential to the development of coal, chromite, uranium, gypsum, and limestone deposits in the basin. Flood control and recreation benefits would also accrue. The irrigation of Chapman Bench was believed infeasible because of the estimated low productive capacity of the land. The Polecat bench area could be irrigated with Clarks Fork water, but is believed more economically irrigated from the Shoshone River as discussed above. The Fish and Wildlife Service believes moose habitat losses would be very important if this development proceeds. There would be other losses in habitat for deer, elk, bear, sheep, and sage grouse. The Corps of Engineers has made an estimate of flood storage requirements of up to 96,500 acre-feet. There may be some chance that the productivity of Chapman Bench and Clarks Fork Valley has been traditionally underestimated. These estimates have been low because of the shallowness of soils over gravel. Modern sprinkler systems might provide the soil water moisture control needed for good production. However, high costs may still preclude development. Groundwater development in this area has probably not been seriously investigated.

g. Bighorn Unit

This is an irrigable area near Worland, west of the Bighorn River and west of the existing Big Horn Canal. Water would be pumped from an enlarged Big Horn Canal with three pumping plants to irrigate about 1,730 acres.

h. Greybull Flat Unit

This consists of 980 acres of irrigable land west of the Bighorn River near Greybull. Water would be pumped from the Bighorn River.

i. Cody Pump Area

This area of about 510 acres about 4½ miles north of Cody could be

served by pumping from the Heart Mountain Canal. Two pumping plants would be required.

j. Ralston Pump Area

One thousand five hundred acres about 8½ miles west of Ralston would be served by pumping from the Heart Mountain Canal.

k. Wind Division

This is a plan for the irrigation of 30,580 acres of new land, nearly all within the Wind River Indian Reservation. Storage regulation would be provided at the Wiggins Site, Raft Lake, and an enlargement of Bull Lake Reservoir. Supplemental water supplies would be provided to presently irrigated lands as well as drainage of some of these lands. Economic justification is considered marginal.

l. Other possibilities investigated by USBR

Emblem Bench, YU Bench, McCullough Section, Sage Section, Upper Dry Creek, North Dry Creek, Little Dry Creek, Whistle Creek, Table Mountain, Red Flat, Kane, Beaver Flat, Pease, Kirby, Hyattville, Bonanza, Manderson, Gooseberry, Schuster Flats, Buffalo Basin, Sheets Flat, Grass Creek, Wagonhound Bench, Putney Flat, Meeteetse Rim, and North Basin Pump.

Corps of Engineers

Manderson, Wyoming, is flooded from both Nowood Creek and the Bighorn River. A levee system has been proposed to provide protection to Manderson from ice jams and open water floods. A study concluded that the project is feasible and may be developed when local residents are able to pay for the local share of the costs.

Bureau of Indian Affairs

The BIA is assisting the Indian tribes of the Wind River Indian Reservation in the development of plans for new irrigation, improved agriculture, new industries, new recreational facilities, and several other projects expected to improve the standard of living of the residents.

NEED FOR FURTHER COORDINATION WITH OTHER AGENCIES

Bureau of Reclamation

USDA and Bureau of Reclamation programs are often quite compatible and should be coordinated. For example, the rehabilitation of existing irrigation systems and installation of drainage in reclamation project

areas can be accomplished through programs of both agencies. Education and technical assistance for improved irrigation water management is available from both programs. The Bighorn RC&D Committee could be a very important group to provide leadership in coordinating activities assisted by the two federal programs.

The Bureau of Reclamation and USDA agencies are interested in management of precipitation or weather modification as are state agencies. Individual agencies should not be allowed to pursue weather modification projects without interagency coordination.

Bureau of Indian Affairs

Activities on the reservation should be coordinated with other activities in the basin. Tribal councils should investigate the possibility of using more USDA programs and technical assistance to improve resource management practices on Indian lands.

Federal environmental agencies

Recently, a number of environmental agencies outside USDA have attained new prominence with legislative direction to regulate pollution, enhance fish and wildlife habitat, improve recreational facilities, and otherwise improve our natural environment. USDA agencies are working closely with these agencies to ensure that environmental values of water and related land resources are protected and enhanced. This cooperation is most effective when USDA agencies coordinate their efforts with other agencies early in the planning stage.

Other agencies should not overlook any opportunity to cooperate with USDA agencies. USDA agencies have large amounts of data about soils, water supplies, crops, and native vegetation and wildlife and have considerable expertise in natural resource management for protection of environmental quality.

Bureau of Land Management

Any program for the public land which affects grazing use will affect agriculture in the basin. A reduction in forage taken from the public land would require either a reduction in animal units in the basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland but would probably encourage an increase of animal units in the basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing land. USDA agencies can and should be actively involved in the development and coordination of such programs.

State of Wyoming

There are many projects which may be developed better with state assistance than with federal assistance alone because federal assistance is limited. The State of Wyoming should be encouraged to expand its present programs of technical and financial assistance programs in resource development. Technical assistance may be available from USDA agencies when financial assistance is not. A vigorous state program may enhance possibilities for federal assistance in the future. Cities, counties, and the State should consider the use of revenue sharing funds for land and water resource development or preservation. The State of Wyoming should seriously consider expanding the capabilities of state agencies to develop water resource projects. These should be multipurpose projects which can include flood control as a purpose.

NEED FOR NEW OR ACCELERATED USDA PROGRAMS

History has shown that existing programs need to be modified or new programs proposed to meet changing regional and national objectives. The emphasis on conservation in the past has been largely focused on measures that would maintain the fertility and productive capability of the land. Although there is still need for these measures, conservation today and in the future must include practices that will protect, maintain, or enhance the environment. Public demands will necessitate new programs that will provide measures which will produce benefits to all people rather than just to the individual farming and ranching operation. These measures will improve water quality, improve and increase wildlife habitat, provide access for hunting and fishing, and develop additional recreation facilities.

It is estimated that only 46 percent of the nonfederal lands will be adequately treated by the year 2000 if present programs are continued at the present level of technical assistance and financing. If we expect to meet additional conservation needs and the changing environmental and recreational demands, both new and accelerated programs will be required; and increased local interest, financial incentives, and the technical assistance will need to be provided. A program such as or similar to the Great Plains Conservation Program, with its features of planning, scheduling, and contracting for installation of conservation measures, would greatly assist the application of these conservation programs in the basin.

Accelerated USDA programs are also needed for state and private forest lands. Cooperative fire management (CM-2) should be extended to the Wyoming counties not currently covered (Park, Big Horn, and Washakie Counties). Timber production, watershed protection, and land use planning needs could be met by accelerating the cooperative forest management, cooperative tree distribution, cooperative watershed, general forestry assistance, and tree planting and reforestation (Title IV) programs. Accelerated use of the advisory management program to assist the State Forester in managerial improvement, work measurement, work planning, and organization and management of programs, would have beneficial effects on all forestry programs.

Acceleration of existing watershed management programs on the national forests would reduce erosion and sedimentation and help stabilize water runoff. Production of needed goods and services from national forest lands could be enhanced by acceleration of on-going programs affecting resources such as recreation, wilderness, wildlife, livestock, and timber.

POTENTIAL USE OF BASIN'S WATER RESOURCES OUTSIDE THIS RIVER BASIN

The physical potential exists to transfer Wind, Bighorn, and Clarks Fork River waters to other river basins. The Powder River Basin, in particular, has forecasted needs far beyond its existing supplies. There is potential conflict between existing and future needs within the basin and those outside the basin. One proposal of the Bureau of Reclamation to build a project for this purpose was discussed earlier in this chapter.

The government of the State of Wyoming will surely be called upon to assign priorities and balance the use of water between river basins in the state.